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METAL PROGRESS

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METAL PROGRESS

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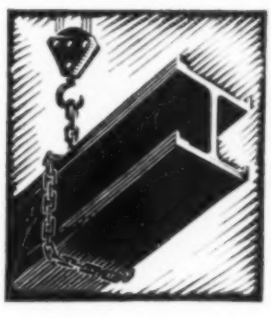

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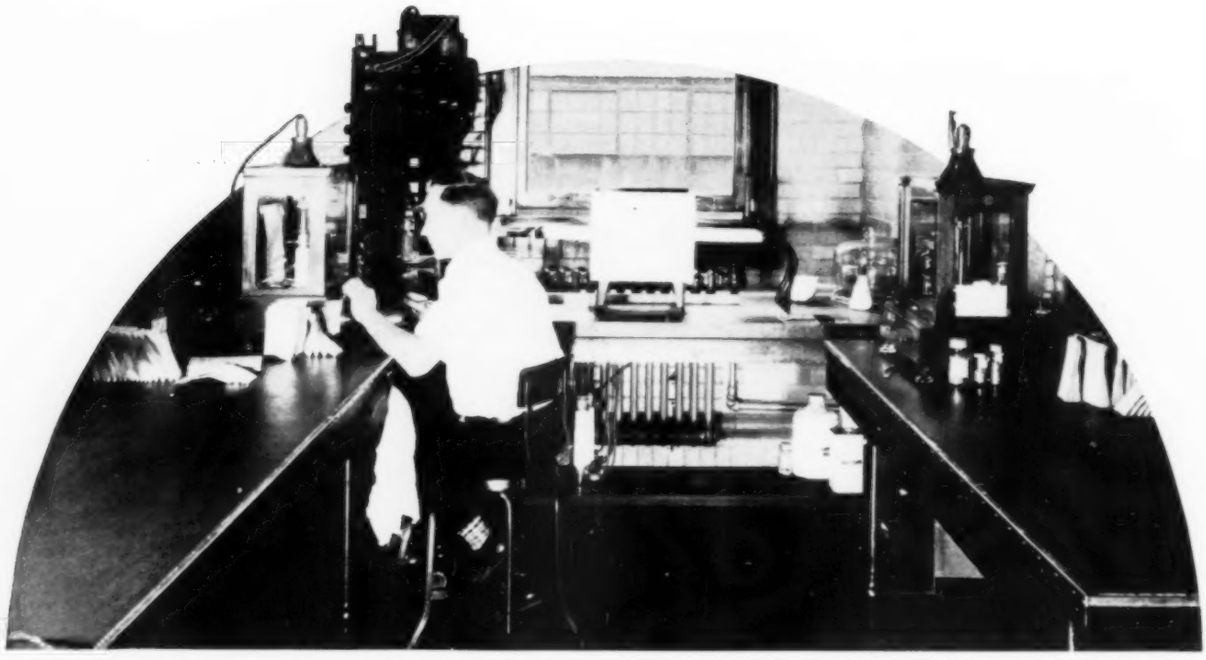
Ernest E. Thum, Editor



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The men who write about the cause and cure of a new forging defect are both well known in the A.S.S.T. WALTER E. JOMINY is associated with the department of Engineering Research at the University of Michigan, and ADAM M. STEEVER is chief metallurgist for the Great Lakes Forge Co. in Chicago. *Page 94*

In the pages devoted to correspondence this month appears a communication from C. B. SAWYER, research technician at the Brush Laboratories in Cleveland. Mr. Sawyer graduated from Yale University and then did work as a post graduate and instructor in heat treatment at M.I.T. In 1921 he was awarded the degree of Ph. D. *Page 89*

The name of ARTHUR S. REARDON also appears among the correspondents. He is associated with Dorman, Long and Co., Ltd., in the construction of the new Sydney Harbor Bridge in Australia. He has been in charge of the tool work and heat treating. An article by Mr. Reardon on the heat treatment of the rivet snaps used on this job will appear in a later issue of this magazine. *Page 91*

The second and concluding section of the discussion of welding by FRED T. LLEWELLYN bears witness to the author's knowledge of the many angles of the great and growing science of welding. Mr. Llewellyn is associated with the U. S. Steel Corp. and is past president of the American Welding Society. He is on the A.S.S.T. Recommended Practice Committee.

The man who writes about the economical melting of bronze in high frequency furnaces is in a position to write authoritatively, for his company melts a great deal of bronze in this way. The author is J. HOWARD WILLIAMS, mechanical engineer for the General Fire Extinguisher Co. at Providence, R. I. *Page 57*

J. C. WEAVER, whose series of articles on pickling is continued in this issue, was a student at Kenyon College when the U. S. entered the War. He entered the service of the government and shortly after the War was put in charge of the pickling equipment department of the Ferro Enamel Supply Co. He is at present vice-president of the Weaver Bros Co., located at Adrian, Mich. *Page 77*

IN THE NEXT METAL PROGRESS

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Automotive Steels

Hard Facing Alloys

Metallurgy on the Coast

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High Test Iron

Low Temperature Furnace

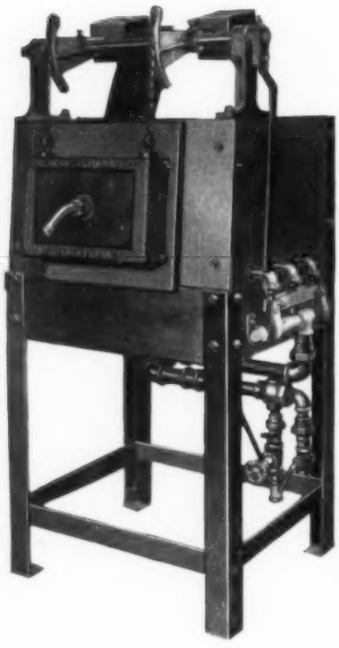
Hardness of Nitrided Case

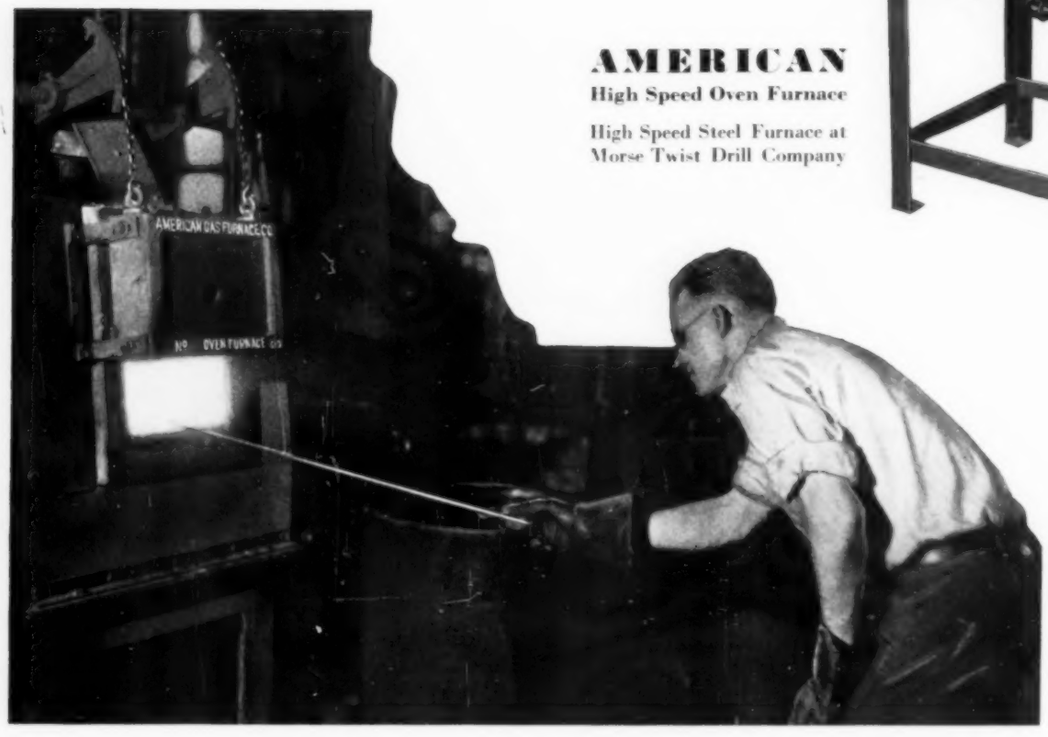
Refining a Steel Bath

Foreign Letters

Editorials

"Atmosphere Control in High Speed Steel Hardening" » » »





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High Speed Steel Furnace at Morse Twist Drill Company

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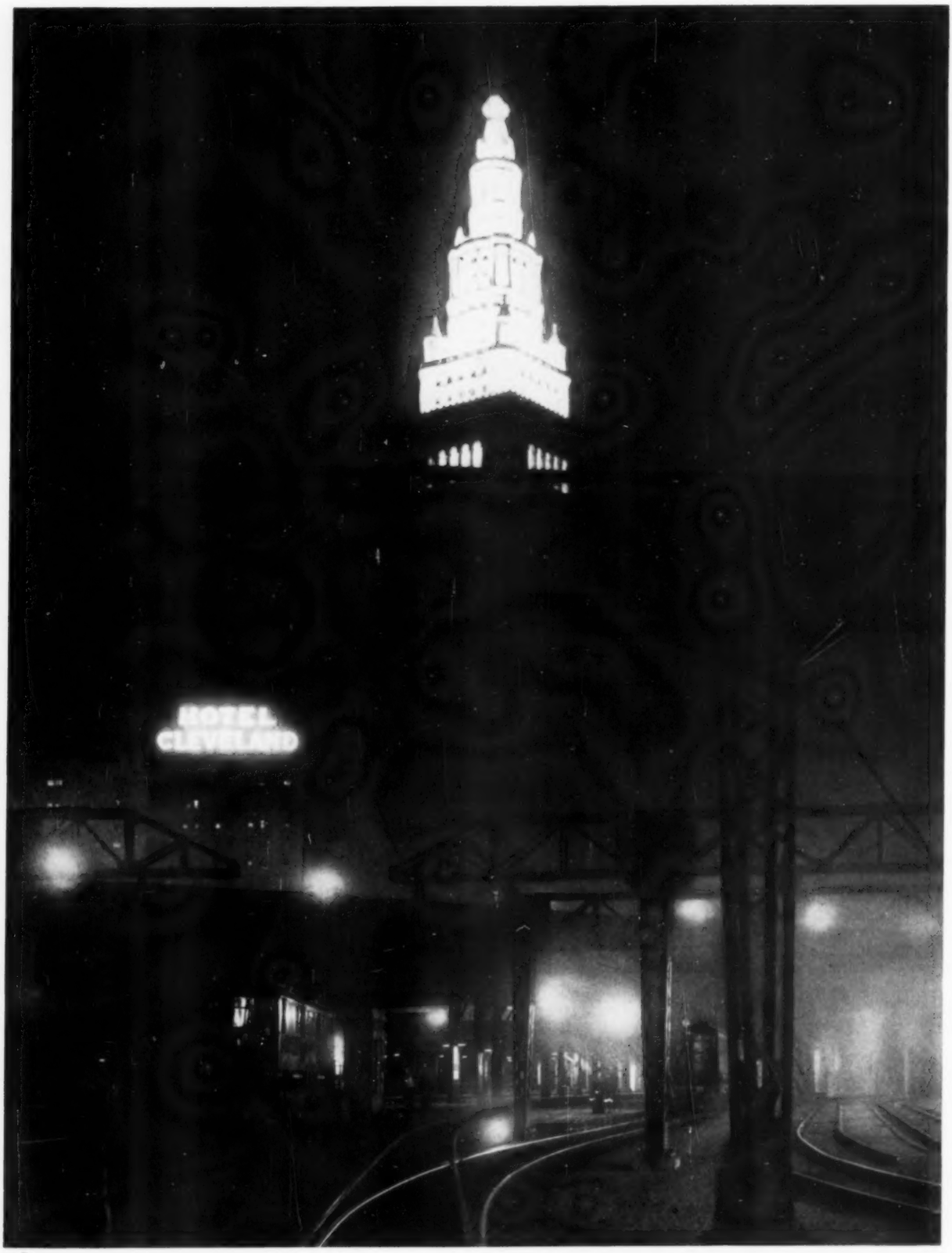


Metal — The Foundation of Modern Construction and Engineering

DIVERSE METALS . . .

IN HUGE TERMINAL

By John W. Love

TRAVELERS coming to Cleveland have for years marveled at the old station on the Lake front — so dirty, so decrepit, so inadequate for a big and thriving city. Patrons of the New York Central, Nickel Plate, and Big Four lines now get an entirely different impression when entering the recently completed terminal. This station project stands today a remarkable combination of unique opportunity with the solution of complex engineering problems, the first application in the West of LeCorbusier's revolutionary suggestion of a city on stilts, and the first conscious effort in America to develop such an area as a unified whole, a "city within a city," an integral system of traffic and circulation within a homogeneous architecture.

It is no less a monument to modern metals — its construction, its operation would be impossible without extensive use of alloys developed each for its specialized duty in present-day life.

Ten years ago the terminal area was a run-down retail and miscellaneous business quarter. Most of the structures on the site had been built in the two decades after the Civil War, and as their original purposes changed and business moved in other directions, they lapsed into dowdy obsolescence. Into this section came men with vision, courage and ample financial resources, headed by two young Clevelanders, O. P. Van Sweringen and M. J. Van Sweringen, and their good friend, Alfred H. Smith, late president of New York Central lines. They acquired 35 acres of streets and buildings, and removed everything — including 3,000,000 cu.yd. of earth — then erected in place a railroad terminal and its approaches costing in the neighborhood of $80,000,000, and the first units of a business district on top of it which bring the preliminary value of the enterprise beyond $100,000,000.

In the course of clearing the site and its approaches, the Cleveland Union Terminal Co. wrecked more than 1,000 buildings. These were mostly of two and three stories; they ranged from wooden shacks to a few fairly recent steel frame office buildings of five or six stories, and included a considerable number of loft buildings of the iron post and wooden beam type familiar from 1870. In place of these were erected on caisson foundation a fabric of steel bridges and girders and tracks, and an integrated skyscraper community over all. Considered mechanically, the new Cleveland station is a triumph in modern metals.

Civil engineers would be interested in the highly ingenious layout of trackage which controlled the form of the terminal. It was due to a number of physical factors, and the problem was worked out under the supervision of H. D. Jouett, one of the principal engineers on the Grand Central Station, New York.

A Four-Track Viaduct Forms the West Approach to Cleveland's Union Terminal. Heavy girders of structural steel and silicon steel compression members, aggregate an unusually large tonnage, to say nothing of reinforcing steel in piers and retaining walls

Cleveland is in the zone where the last of the Appalachian highlands look out over the beginning of the prairie. Streams gully the escarpment of the plateau as they tumble to the plain and to a valley below the plain, the corridor of the Cuyahoga River. These three levels — highland, plain and valley floor — and the gullies which connect them are the essentials in the physical background of the new railroad terminal.

The gullies enabled the railroads to approach the center of the city cheaply. The valley through the middle made it possible to build a terminal on its edge without excavating too much soil. The highlands four miles to the eastward support a population capable of utilizing an extensive rapid transit system. This system of high-speed electric lines, and the traffic fed into it, would in turn support a retail and office building district capable of paying for the air-right construction. Altogether, the economics were as ingenious as the mechanics, but this article is concerned more with what might be called the metallurgy of the central terminal.

Cleveland Union Terminal may be divided for purposes of description into three parts, the railroad station, the approaches and the air-right buildings. The station and the approaches were built by the Cleveland Union Terminals Co., owned by the New York Central, the Big Four and Nickel Plate railroads, with C. L. Bradley, the chief executive. The air-right buildings were erected by the Cleveland Terminals Building Co., one of the enterprises sponsored by the Van Sweringen brothers who conceived the project and coordinated the various units necessary for its success. The station is almost wholly beneath the first floor level of the buildings. The ones now erected rest, in fact, *upon* the station. Five air-right buildings have already been completed including the Hotel Cleveland, the Terminal Tower (52 stories) and three others about 18 stories high. A large structure for a department store is now under construction and hotel, general post office, and other buildings are in the background. The unit is an architectural whole, designed by Graham, Anderson, Probst & White, of Chicago, represented on the ground by Major John M. Snead.

Up to today, there is, in the whole development, 134,000 tons of structural steel. The heaviest group of structures was the bridges, (including the viaducts for overhead street traffic) which consumed an aggregate of 58,500 tons. In this group were six viaducts carrying streets over the area, 13 railroad bridges within the area known as "terminal approaches," and 38 more erected on the New York Central or the

Nickel Plate right-of-way — more in number and heavier in construction than all the bridges Cleveland had built up to the time the terminal work started. Catenary structures for trolley and signal supports used 3,615 tons more steel in comparatively light shapes.

The total weight of the steel in the surmounting buildings (not including the station) is 53,000 tons, and in addition there is a minor item of 2,000 tons or more of reinforcing steel.

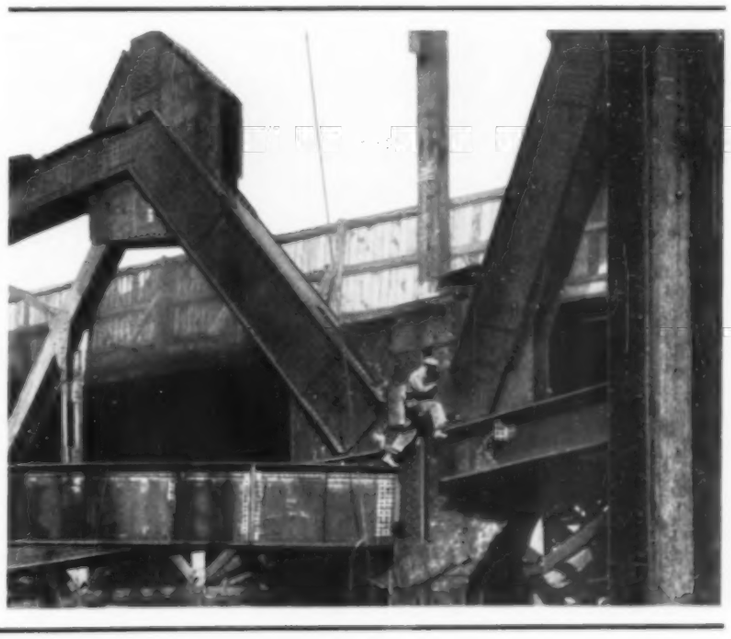
These steel orders were placed during about two years, and while they were coming out, they represented the largest purchases in the structural steel industry. A succession of large orders for closely related projects is indeed rare in industrial history. The Grand Central terminal district in New York contains a considerably larger steel tonnage, considered as a unity, but it has been developed over a period of at least 20 years.

All the weight of the giant Cleveland fabrication rests on caissons running through a sandy soil to rock 250 ft. below the street level. Some of these caissons carry as much as 5,600 tons load. In themselves they are unique not only for their great depth, but they were the first to be employed in Cleveland — the practice on large work prior to this was to set buildings on piles behind cofferdams or "float" them on thick, heavily reinforced concrete rafts.

The streets running through the terminal area, nearly three-quarters of a mile of them, are structurally independent of the station and of the buildings above it. Their column spacing meets the requirements of the trackage beneath but they stand by themselves, with their expansion joints running across the station floors. The independence of the streets, the special requirements of the station and the needs of the super-grade office buildings introduced a complex problem in design. Many heavy trusses, such as shown below, transfer the weight of the superstructure to places where strong columns could be erected. In one instance, there are two sets of these trusses; the lower one rests on columns placed between the curving railroad tracks, and the upper set carries the upper floors of an air-right building across the clear spaces reserved for concourse, waiting rooms and other station facilities just below street grade.

American Bridge Co. fabricated structural steel in the terminal with the exception of about 10,000 tons from Mt. Vernon Bridge Co. Most of the columns were of open-hearth silicon structural steel, quite similar to the analysis and properties used in the main towers of the mammoth Hudson River suspension bridge now under construction. This low alloy steel, when built into columns, permits loads nearly 25% greater than a duplicate made of the ordinary structural steel of commerce. The remainder of the skeleton is medium carbon; nearly all the beams in the station are the Carnegie wide flange beam, which commenced to be rolled at Homestead, Pa., in February, 1928, as the station work was getting under way.

The special problem of ventilating a sta-



Heavy Trusses to Carry Towering Buildings Over the Labyrinth of Trackage and the Station Concourse. A skewed location of buildings on a triangular plot is responsible for highly intricate steel work

Ornamental Bronze, Copper and Stainless Steel Are Commonly Used for Decorative Effects Outside Main Entrances of Modern Office Buildings. Nickel, monel metal, stainless steel and other white alloys are favored for interior trim

tion so completely enclosed was undertaken with 800 tons of galvanized air ducts served by more than 50 fans. The Jacob Halter Sons Co., which installed the air-conditioning system, also used eight tons of "everdur" (a copper alloy made by American Brass Co.) to carry acid vapors from the battery charging rooms.

Interior ornament in the station included large amounts of "statuary" bronze or heavy cast bronze, employed in display windows, door frames, ventilator and radiator grills, lighting fixtures, ticket windows, announcement boards and gates. An idea of its artistic excellence can be gained from the view shown above of the entrance of one of the super-grade buildings in the station area.

Monel metal, nickel, aluminum, copper, were plentifully used in the kitchens of the several restaurants on the concession area of the terminal — metals in such variety as to warrant a special article "Pots 'N Pans" in last November's METAL PROGRESS. Exposed plumbing fittings around the station and in the air-right buildings employed "chromard," a chromium plated brass which Standard Sanitary Manufacturing Co. has been making for about two years.

Going down to the track level and looking out at the yards and the approach tracks, it is found that the tracks within the station and on the approaches are of 127-lb. rail. Frogs in the turnouts are of manganese steel, and the space between the tracks is curbed to make a utility trough and covered with a grill. For the pur-

Large Windows Require Substantial Steel Frames and Bracing. Metal doors, or metal encased doors and frames are installed to increase fire resistance—in fact, trim of all sorts consumes a considerable tonnage of sheet steel and strip

poses of station operation, the tracks are electrified along the approaches and beyond, a distance of 17 miles. Signals and catenaries are carried on overhead lattice bridges of a great variety of design to conform to the requirements of the individual location. The main catenary cable is used for electrical conductivity and is therefore made of bronze strands surrounded by copper strands; it suspends the trolley wire of conventional hard drawn copper. High strength cable for guying, galvanized malleable iron, and special alloy fixtures abound in this work, which, according to the electrical engineers, is the most involved of its kind ever encountered, including as it does an excessive number of curves, very little tangent track, close clearances, wind and sleet loads, 300-ft. average spans, and a permissible vertical movement of only two feet for the main messenger cable.

Signals in the station area are controlled by 576 levers in the largest single interlocking machine ever installed.

The longest of the 51 bridges erected or re-erected for the terminal development is located at the beginning of the western approach. It is 3,450 ft. long, located on a 5° curve and a 1.56% grade. It consists of 29 girder spans set on massive concrete piers, as shown in the view on page 38, and terminates at the west in a long trussed bridge crossing the Cuyahoga River at a height sufficient to clear the masts of the Great Lakes ore carriers. This bridge had to be placed without false work, on account of the river traf-

Unusually Heavy Girder Construction in Western Approach. Structural steel awards for the entire Cleveland terminal project featured the market news for a period of two years

fic, and this was accomplished by erecting it as a cantilever, using chains of eyebars for temporary anchorages, the connections of which were burned off with a cutting blowpipe after the trusses reached the opposite pier.

Drainage along the track and from behind the very extensive concrete retaining walls is effected by Toncan iron and Armco corrugated iron pipes, with cast iron pipes crosswise of the track. An unusual amount of high retaining wall, erected along the depressed trackage, consumed large tonnage of reinforcing bars, rolled at Bourne-Fuller plant within rifle shot.

Over this interlacing of tracks and circuits operate more than a score of 204-ton electrical locomotives, the joint product of General Electric Co. and American Locomotive Co. The frames of these 80-ft. machines are of cast steel, their driving wheels solid rolled steel. Copper, of course, forms the bulk of the electricity-carrying equipment inside these machines, but many special varieties of steels and other alloys go into their construction.

Returning now for a more detailed look at the air-right or super-grade buildings piled on top the station and approach trackage, we find an important item covered by the specification called "ornamental iron and bronze." The Flour City Ornamental Iron Co. did the work on the Tower building, and before the same work had commenced on the station, the company had been merged into General Bronze Corp. Another of its subsidiaries, Wisconsin Steel & Iron, did similar work on the Medical Arts building, illustrated in part on page 36.

W. S. Tyler Co. of Cleveland made the elevator entrances on some of the buildings and the elevator cars on all, the elevator machinery and control being built by Otis Elevator Co. Elevator cars in the Tower are made of steel sheet with baked enamel finish, bronze castings in the grills, and the bases of sheet bronze. Elevator entrances in two buildings are solid color enamel.

Many first floor entrances have been done by the Tyler Company in an inlay developed about three years ago, whereby intricate designs or marquetry are executed in wood veneer and "benedict nickel." The work follows the exuberant tradition of the great marqueteurs of two centuries ago. The metal may be of any kind — steel, bronze, aluminum — the wood also of any sort, but the alloy much used by Tyler is made of nickel, copper, tin and a little chromium.

Tonnages of metal large in the aggregate were employed on these buildings in sheet metal work, doors, windows, plumbing, heating, conduits, hardware, pneumatic tubes, lighting fixtures, vaults, electric cable — the innumerable fitments of the modern building — and these were, in general, the types in any modern office structure. After the building rose above the mezzanine or second floor the unusual construction problems ceased to appear.

Such a sketch as this can but poorly body forth the details of this intricate undertaking. Perhaps, however, it has brought forth the fact that such a building project, designed to focus and unify all forms of metropolitan traffic — railway, rapid transit, automobile and pedestrian — is a vast complex of metals and stone, but of these, metals are supreme.

CARBURIZING WITH GAS IN UNDERGROUND RETORTS

By W. F. McNally

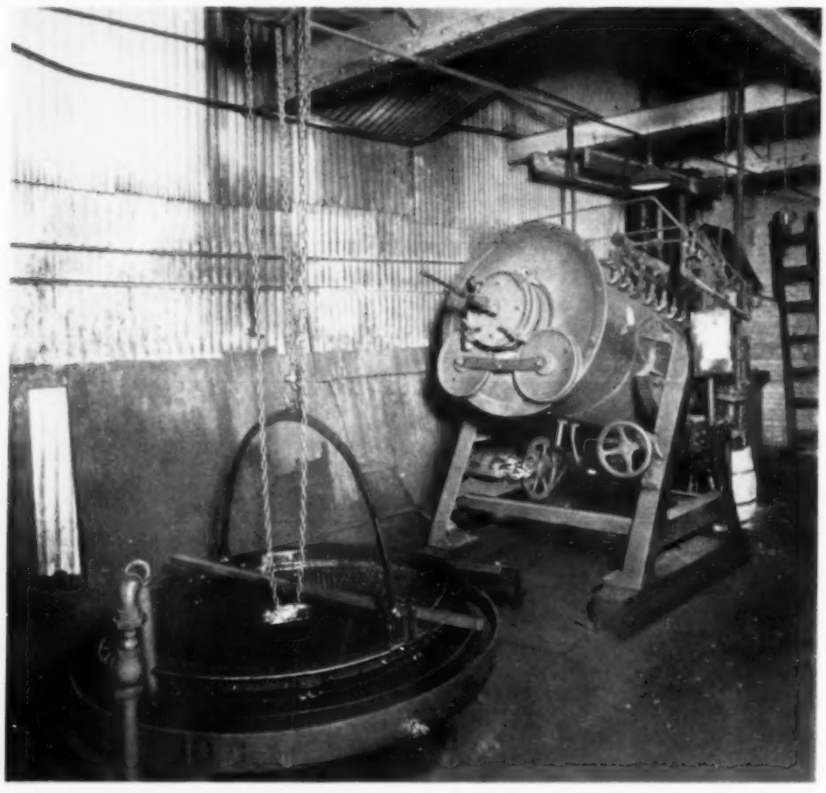
GENERALLY speaking, the carburizing process is usually thought of as a reaction between the steel to be hardened and a solid carburizing material, under properly regulated heat. When operated in this manner, the method involves the use of the necessary furnaces to produce the desired temperature for a sufficient time, the containers of various shapes and designs in which the work is packed with the solid carburizing compound or material, and the hoists or trucking equipment for loading the containers in and out of the furnaces. In addition, provision must be made for storing the carburizing compound, separators or graders must be installed to clean used carburizing materials, and some method used — mechanical or otherwise — for mixing the cleaned and graded used material with the proper amount of fresh carburizer, for further use.

The very nature of the operation, as conducted commercially on a production scale, requires the appropriation of valuable space for the preparation of the work for actual carburizing, and large investments for containers (where non-ferrous alloys are used for such equipment). Losses due to break-down and the shrinkage of the solid carburizing material are high, and have to be considered in any appraisal of the cost of the operation.

Necessarily then, the labor of handling a solid carburizing material and packing and otherwise preparing the parts to be carburized, together with the interest charge and rental on storage space for idle equipment such as the carburizing boxes, containers and carburizing material in stock, all are cost items which enter into the total when carburizing by means of a solid carbonaceous material, and must be considered.

As a matter of fact, the process depends on chemical reactions between the steel to be carburized and a gas, or gases, in immediate contact with the steel. This fact has been amply proved. While it is probably possible for steel to absorb carbon from solid material at the very point of contact, it is certainly true that practically all of the carbon added to the surface layers of the metal comes from gases distilled from the solid packing materials at furnace heat, or from carbon monoxide formed by the same material burning in the air trapped within the pot. What then would be more logical than to use a prepared gas if a suitable one could be found, readily available without the installation of a special generating plant?

As a preliminary step to finding out the possibilities of carburizing high quality automotive parts with gas, the rotary retort furnace shown in the illustration on this page was obtained. Preliminary tests were run with scrap parts, in order to determine such things as the time required to bring the charge to tempera-



Rotary Gas Furnace in Which Was Done the Investigative Work. Now operated on dehydrated city gas. Net capacity is 700 lb. per charge. Quenching tank is in immediate foreground.

ture, and the uniformity of this temperature throughout the charge. After once establishing a suitable time-temperature cycle, test runs were made, using ordinary 530-B.t.u. city gas, of the following composition:

Carbon dioxide, CO_2	3.00%
Oxygen, O_2	.60
Carbon monoxide, CO	12.10
Methane, CH_4	29.80
Hydrogen, H_2	44.60
Nitrogen, N_2	5.60
Illuminants	4.30

Pressure of the gas inside the hot retort was maintained at eight ounces, in this first series of experiments, and the amount of gas passing through the hot retort for carburizing was controlled by means of a valved pipe screwed into the outlet cover. The depth of the case and its carbon content were carefully checked on repeat runs, both microscopically and by chemical analysis.

Satisfactory carbon concentration was not obtained at first. Thinking that this might be due to a lack of carbon-bearing gases in the city gas, 1 lb. of solid carburizing materials was charged into the retort with every 50 lb. of steel. This practice gave us much better results and was continued on some production runs for a short period of time while further investigations were carried on.

The next successful step in the use of gas alone was with pure propane, this gas being delivered from cylinder containers to a mixer or carburetor, where gas and air were proportioned before delivery to the retort. The relative proportions were constantly checked by chemical analysis. Carbon content of the case obtained with various proportions of gas and air was determined.

As a final result of this series of large scale experiments, it was found that a mixture of 40% propane and 60% air would give the desired case. The microscopic appearance of the case, transition zone, and core when using this mixture is shown on page 43, and it may be compared with similar micros for steels heated with other carburizing materials.

This mixture of propane and air was used on a production basis for a period of time, while

extending the investigations on city gas in order to determine whether it could be used successfully as a carburizing medium.

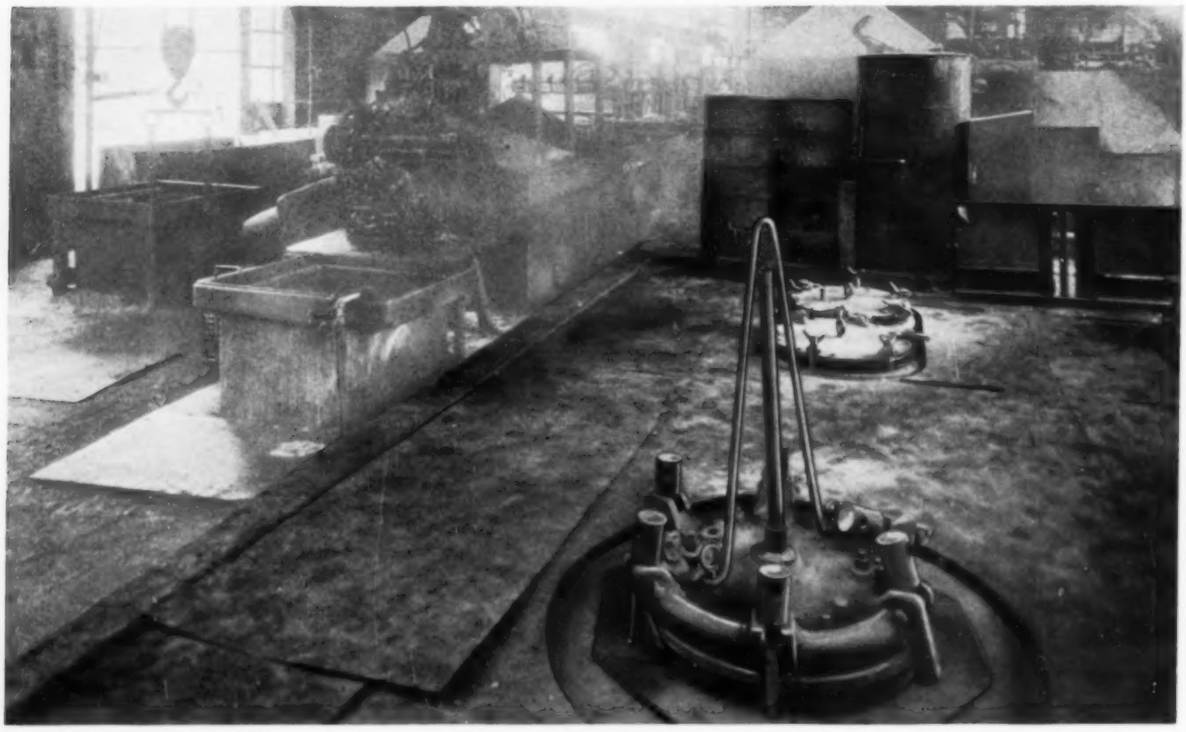
After extended tests, city gas was again tried. This time the gas was thoroughly dehydrated and the carburizing process carried on with 15 lb. pressure. Marked success, both as to the carburizing time and the quality of the case was achieved.

In order to determine what part pressure played, a number of runs were made using dehydrated gas at 8-oz. pressure. It was found that it required an appreciably longer time to produce the desired depth, although the quality of the case was equal to the quality of the case produced under the higher pressure. In the event that only low pressure gas is available, it would require some accounting to determine whether the amount of work going through would warrant the expense of a booster for the gas pressure.

It so happens that one of our plants uses natural gas for fuel. Based upon our success in other plants using city gas and propane, it was decided (when expansion became necessary) to install a battery of pit-type carburizing furnaces in the production line. These new furnaces, shown in the view below and on the next page, embraced a new feature which added materially to the already excellent thermal efficiency of the furnaces themselves.

This feature consisted of a heavily insulated double chamber. In effect it is an airtight container, or, as it was called, a heat exchanger. It is large enough to take two furnace charges — one charge already carburized and ready for cooling, the other side of the chamber for a cold charge ready to be carburized. By means of suitable vents between the two sides and the introduction of a suction fan beneath the cold charge, it was possible to preheat the cold charge to 800° F. by the heat dissipated from the carburized charge, heat which would otherwise be wasted.

Gas Carburizing Machine Set in Production Line. All settings, burners and flues are in a well-insulated pit, and only a slight amount of heat is radiated through top into surrounding room. Below ground are also air blowers, temperature controllers and gas dehydrators. Tops of carburizing retorts appear at the right, each having a net capacity of approximately 2,400 lb. of small automotive parts. At the left of the view are seen the tops of the heat exchangers.

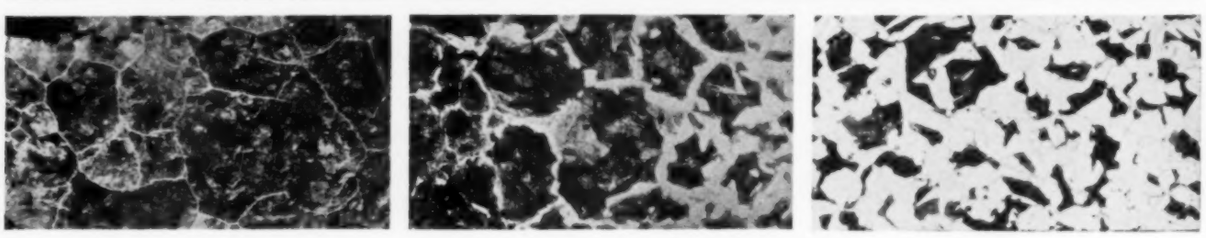


Pit-Type Gas Carburizer. Top of heating chamber in foreground; tops of heat interchange pit in middle distance. In the background are stacked the perforated baskets for work while in the furnace, and the shroud used to protect the hot metal while transferring from furnace to heat interchanger.

This system of operation not only reduced the total time necessary to heat the cold charge to temperature in the carburizing furnace, but thereby increased the furnace production per hour and enabled the department to handle a greater number of parts per hour than the originally estimated capacity.

Natural gas also worked very successfully as a carburizing medium. Compare the microstructures as shown along the bottom of the opposite page with the others. The furnaces cause no heat or dust nuisance, and are placed in the production line without any housing; no difference in the nearby room temperature is noticeable.

Furthermore, their operation is as nearly automatic as could be desired. Parts to be carburized move down conveyors from the machine line to the point where holding fixtures are loaded. By the simple expedient of proper timing, one man with no great physical effort can attend the entire installation. All handling is done by means of an electrically operated over-head crane. The furnace attendant loads and unloads the carburizing fixtures, charges and discharges the furnaces, and



Case, Transition and Core of Piece Carburized With Solid Material

watches his temperature recorders. He has no carburizing compound to handle, and no fuel valves to manipulate (as the furnace temperature is controlled automatically); there is no big supply of boxes cooling down or being packed, and the result is a machine-like precision that adapts itself to quality and quantity production.

From the foregoing it may be seen that we have successfully used three different types of gases for carburizing, namely, dehydrated city gas, pure propane gas, and natural gas. Undoubtedly there are many others that will work with equal success.

It so happens that retort furnaces now available lend themselves to the shapes we wish to carburize in them, and therefore work to our advantage. It is well to recognize the fact that there are other shapes that the present types of furnaces do not lend themselves to readily, inasmuch as the parts cannot be placed in such a manner as to occupy the retort economically.

We believe we have obtained certain well-defined advantages from gas carburizing over the process of carburizing by means of a solid carburizing material, and these advantages may be summarized as follows:

1. Lower labor cost.

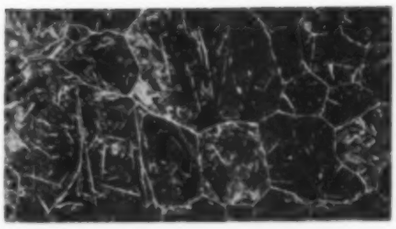
2. Lower fuel cost: (a) By pre-heating; (b) By eliminating the insulating effect of a solid carburizing material; (c) By the fact that retorts are always at temperature, as compared with the heating and cooling down of containers when solid carburizing material is used; (d) By control of temperatures, the parts are brought to temperature before the admission of any carburizing medium.

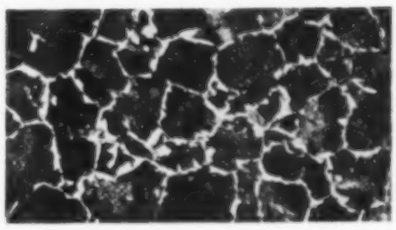
3. Lower cost of carburizing medium.

4. Uniformity of the desired results: (a) Depth of case; (b) Carbon concentration of case.

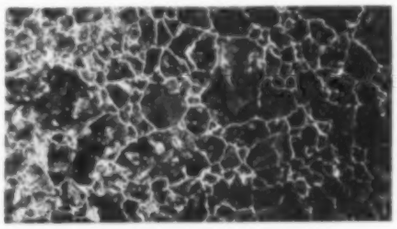
5. Lower container cost. The retort, being constantly under temperature, has not the disadvantages of cooling down and heating up repeatedly; consequently the life is increased materially.

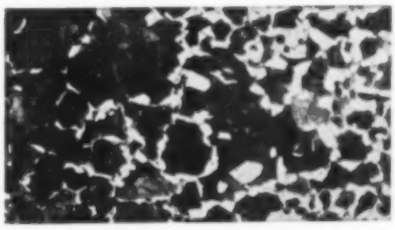
6. Flexibility. The smaller units permit the meeting of production schedules in a manner much more readily than that obtainable by any other type.

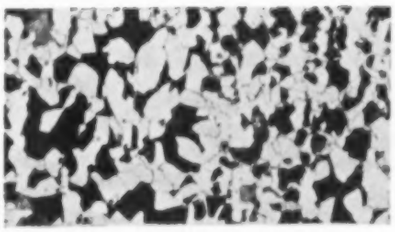




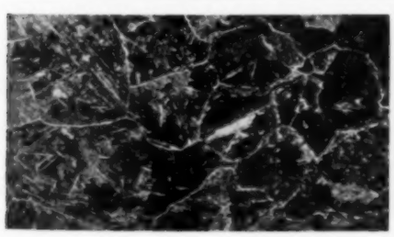
Hyper- and Hypo-eutectoid Zone of Piece Carburized in City Gas Containing 80% Coke Oven Gas

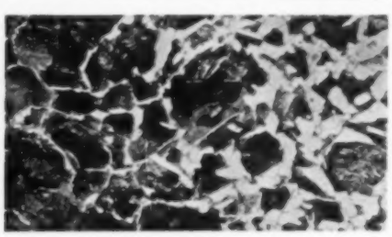


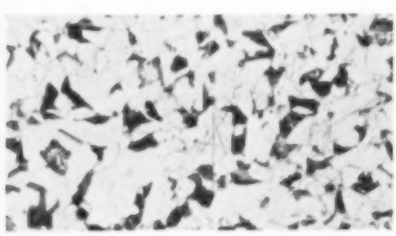




Above Three Micros Represent Case, Transition and Core, Carburized with 40% Propane, 60% Air







Case, Transition and Core of Piece Carburized with Natural Gas

By Charles E. Herd

STAINLESS STEELS USED IN HEAVY MACHINERY

MANUFACTURERS of heavy machinery are having imposed upon them ever increasing demands due to space restrictions, weight considerations (or a combination of both), together with requirements for rust- and acid-resisting properties as well as higher physicals at elevated temperatures. Such requirements have been met by the utilization of ferrous and a host of ternary and quaternary alloys. Some of them have known composition and registered trade names. Compositions of others may be unknown to the engineering profession at large, yet have familiar physical properties because they have been extensively advertised under particular trade names or brands. Lastly there is available as a most important class the readily recognizable and large choice of alloys recommended by the Society of Automotive Engineers, American Society for Testing Materials, British Engineering Standards Association, and the Canadian Engineering Standards Association.

Fortunately, the designer and engineer finds in his hands the means to select intelligently and economically that particular alloy which will most satisfactorily fulfill the conditions or requirements of a particular design. He is indebted to the rapid advance that has been made in the art and science of metals during the present generation, and the wealth of data accumulated by the researches and experiments by eminent scientists and metallurgists.

Prior to the War, about the only information of this sort available about the special steels came from the makers, information (it may be said) not always as accurate as it might be. This situation has changed radically. Steel manufacturers generally are now aware that their technical publications are perused by very critical readers, and in consequence, there has been a marked improvement both in the arrangement and completeness of the data given. Many of these publications are worthy of a prominent place in the library of every engineer.

Willingness of steel and alloy makers to cooperate with the engineering departments of their customers on some intricate problem of design in which a proper selection of the correct materials is of vital importance, is a service that cannot be commended too highly, and has contributed in no small measure to the satisfactory solution of many difficult problems and the ever increasing use of special alloys.

Undoubtedly much wider use will be made of this service, resulting in a closer cooperation

between the metallurgist and the engineer, with a correspondingly steady improvement in the stability of structures generally.

Coming now to specific instances, let me note some of the applications of stainless steel made within the last three years by the Dominion Engineering Works in the construction of paper mill machinery and hydraulic turbines.

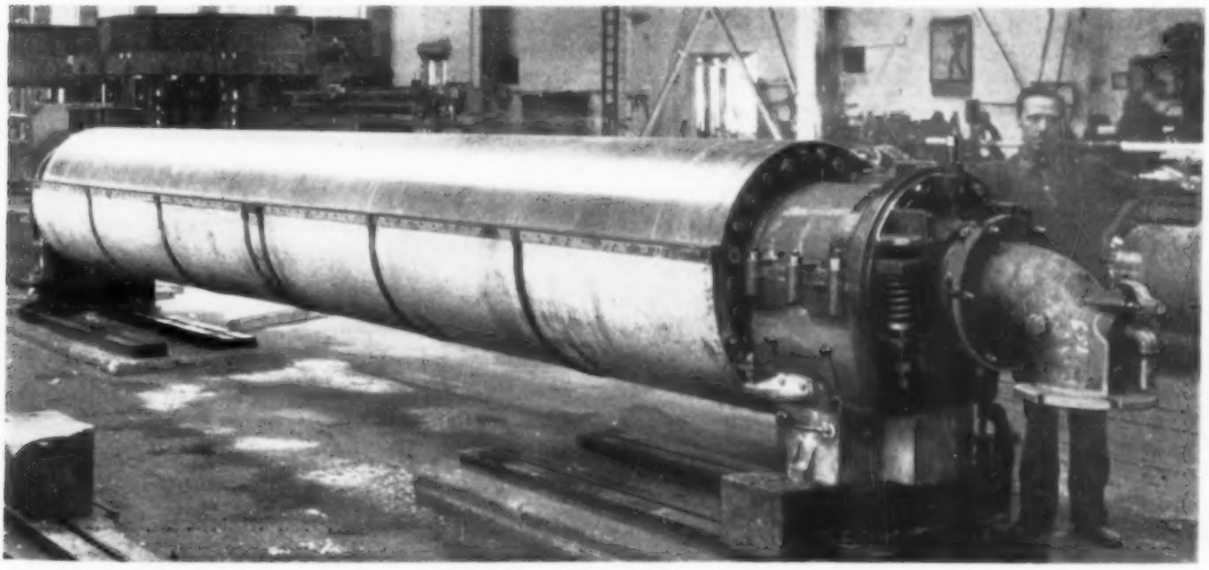
Perhaps one of the most recent and outstanding examples in the application of stainless steel is a "Millspaugh" patent suction press roll, shown completely assembled in the view at the bottom of this page. This was installed during 1929 by the Abitibi Power & Paper Co., Ltd., on their 232-in. news print machine at Iroquois Falls, Ontario.

This roll was forged from a 14% chromium steel billet; the dimensions when finish-machined being 30 in. diameter, 20 ft. long, with a wall thickness of 1½ in. Following turning and boring, almost 120,000 holes, 11/64 in. diameter, were drilled through the shell on accurate spacing, each hole being slightly chamfered on both inside and outside surfaces to remove all sharp edges. At the outset considerable difficulty was experienced with this drilling operation, but the matter was corrected after experimentation and the work finished without further trouble.

As a manufacturing experience, as well as affording an opportunity to secure valuable data on the serviceability of such a roll under actual operating conditions, this was a most interesting and unique experiment, although there is some doubt of its becoming standard practice, at least for some years. Ordinarily such rolls are cast in loam molds of a close-grained gray iron — a practice which indeed has required much experience to produce such large tubes perfectly free from defect. Minor porosity appearing after part of the extensive machine work had been done would, of course, be ruinous.

When comparing alloy steel forgings to gray iron castings, it must be remembered that a great price differential exists, and that, after all, the dollar sign looms large before the chief designer. Every move he makes is governed by dollar values in an attempt to meet the keen competition which is prevalent today in practically every branch of industry. This is in some ways a most unfortunate condition, and is undoubtedly responsible for the somewhat slow adaptation of new metals to established lines of machines. Only when the added cost is clearly justified by a more than proportionate increased

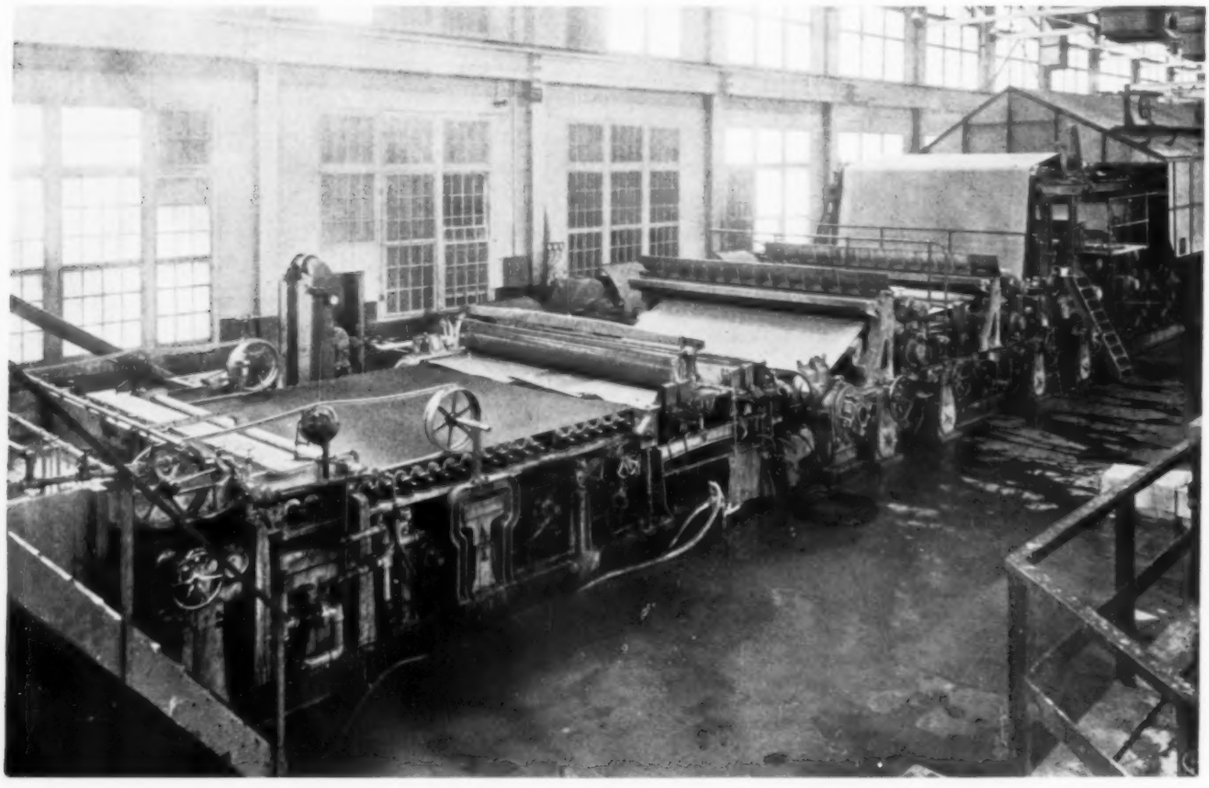
Hollow Forged Billet of 14% Chromium Steel. Machined to 1 1/2 in. wall thickness and perforated by 120,000 drilled holes. It is a suction press roll for a paper machine, similar in design to those ordinarily machined from gray iron, cast in a loam mold.



value of the product can such a change be made.

Stainless steel has also been used since 1926 in the "Fourdrinier" or wet-end of paper machines built by the Dominion Engineering Works for all parts subject to the corrosive action of water and stock which were formerly made of mild steel, with most gratifying results.

Fourdrinier or Wet-End of Machine for Making Paper From Wood Pulp. Stainless steels in modern machines of this sort replace many mild steel parts which show harmful corrosion from water, pulp solutions or stock.



It has now become standard practice on the class of machinery shown herewith. Being nonmagnetic, deterioration through electrolytic action is practically eliminated and, since it has unusually high resistance to dynamic stresses, there is no doubt but that it will become more generally used when these characteristics are better known.

In the field of alloy steels, proper selection of a suitable variety is ofttimes a serious problem. It involves not only consideration of the physical characteristics, both normal and latent, but also price and availability of suitable sizes of stock. Machineability is an important consideration; likewise the ease with which scrap may be sold as well as the value recovered.

Since the general run of alloy steels, in their normal or as-rolled condition, have very similar physical properties (as measured by the standard tensile test piece) and, since these are invariably better than acid or basic hypoeutectoid steels, being more free from nonmetallic inclusions and therefore capable of withstanding greater punishment, the natural tendency is to use them for most conditions where the working stresses are higher than would be safe for low carbon steels except in a heat treated condition.

Moreover, the fact that alloy steels generally have latent possibilities which can be developed by heat treatment has undoubtedly influenced engineers to make much more frequent use of them in machinery construction, with a cor-

responding improvement in stability and appearance and reduction in weight.

As a consequence, one finds alloy steels are now used in hydraulic turbines for such parts as link pins, keys, coupling bolts, patch bolts, shafts and other parts which were formerly made of mild steel.

In making the comparison between alloy steels and medium carbon machinery steels, it should be noted that the remarks refer to carbon steels as produced on a large tonnage basis by the open-hearth process. Crucible or electric furnace steels, as commercially available, are in an entirely different class, and the main reason they are not used more frequently is that they are invariably quoted to us at higher unit costs than the alloy steels.

Hydraulic turbines form a second class of machinery for which austenitic steels have great promise. While much of the detailed information is yet for the future to develop, we have been encouraged to make definite applications on some very large installations.

Nearly all users of metal have at some time or another come face to face with quite unexpected but quite powerful abrasion by true gases and clear liquids. To steam users the "wire-drawing" effect of a small jet of high pressure steam is known to destroy a valve in short time. Propellers for ships, large and small, become deeply pitted on surfaces which seemingly should be free from wear. Corrosion of steam turbine blades and vanes has been frequently discussed.

While the causes of these phenomena are not identical, they are like the pitting which occurs on runner blades and draft tubes of hydraulic turbines. Mechanical abrasion is the factor responsible for most of the damage, rather than chemical corrosion. As a matter of fact, forces of corrosion and erosion both may be resisted by the stainless austenitic steels. Their introduction, particularly since they are now commercially available in the form of plates, sheets, bars and tubes, has given the turbine designer another weapon to combat the ravages of corrosion and erosion, although the present cost of this material may prevent it being used except for special cases.

An experiment is now being conducted by the Hydro-Electric Power Commission of Ontario on one of the 58,000-hp. turbines in the Queenston plant. The upper portion of the draft tube, immediately below the discharge from the runner, has been completely lined with this material. The plates were purchased flat, and cut and formed cold by the turbine manufacturer. They were then attached to the base casting by patch bolts, the heads of which were set below the surface and each void filled in with stainless welding rod. The whole surface was subsequently ground to a smooth contour. The liner described is in that portion of the foundation structure which carries the water, immediately below the discharge edge of the runner or rotating element at the bottom of the main shaft.

No data on the success of this plan is as yet available, since the unit has only recently been placed in service, so that nothing further can be given beyond citing this as another instance where stainless steel has been used in the manufacture of hydraulic turbines, following the lead of experiments to be described more fully below.

In an effort to avoid pitting in the runner blades of high speed turbines, high chromium steel castings have been used. The illustration on page 48 shows such a runner. (This one is for a 16-in. experimental turbine, and has adjustable blades, but the shape is similar to others made of a one-piece casting up to 16 ft. diameter.) Here, again, the matter of cost enters. It seems unreasonable to make the whole piece out of an expensive alloy to resist pitting which occurs on a relatively small area of the surface. This might, indeed be necessary, were it not possible to build composite structures by the welding process.

Welding, although known in an experimental way for many years, may quite conceivably be classed as a comparatively recent discovery — one of the modern achievements of the metal industry. Its progress, since the process became commercial, is nothing short of phenomenal.

A most valuable feature of it, for our present consideration, is that it is now possible for a skilled operator to make surface deposits of various compositions of alloy steels on ordinary carbon steel.

This process is known as "prewelding" or

"over-laying" to us and as "hard-surfacing" to welders in the States. It proves fair to become exceedingly useful to hydraulic turbine manufacturers, particularly since the introduction of runners of the high speed propeller type, because one can now preweld those areas that have been found susceptible to pitting with an alloy of known resistance to these actions and thus prolong the life of the part so affected.

In the making of a one-piece turbine runner the building of the pattern and core boxes, molding and making the cores in the foundry, handling, placing and drying these green cores in the oven, together with the operation of placing these cores in the mold and subsequent strains while the casting is being poured, as well as the possibility of distortion during annealing —all these are factors which may cause the finished casting to vary from the lines originally laid down by the designer. Quite naturally, these variations become more pronounced as the castings increase in size and weight.

Such unavoidable variations can be corrected by over-laying. But my purpose is to show how such overlays may profitably be made with special alloys.

In an effort to ascertain the value of this process under actual service condition an interesting experiment is now being conducted on a cast steel runner of one of the 28,000-hp. turbines installed in the Great Falls plant of the Manitoba Power Co.

This runner is 15 ft. 9 in. diameter, weighs 51,000 lb., and was cast in one piece, the blades being integral with the hub. The metal had a carbon content of 0.20%, with 0.75% manganese, 0.015% phosphorus, 0.024% sulphur and approximately 0.33% silicon. Test coupons gave an ultimate tensile strength of 76,000 lb. per sq.in.; yield point of 40,600 lb. per sq.in.; elongation 26.5%, and a reduction of area of 44.1%.

Before being finish-machined, the back of each of the six blades, at the discharge edge, was prewelded over an area of approximately 12x12 in. The welding rods used varied in composition from standard low carbon steel to chrome-nickel alloy and the high chromium stainless variety, a definite composition being assigned to each blade.

This runner has been in continuous service since its installation in 1927. Periodical inspections since then have been very encouraging; the most recent one showing conclusively that both chrome-nickel and the stainless variety of welding rods resist pitting to a marked degree. In fact the surface of the two blades, which had been prewelded with these alloys, showed no signs of pitting whatever, being as smooth as when first installed.

As a result of this experiment, the process was put into practical use on the 14,000-hp. turbines recently installed in the Island Falls plant of the Churchill River Power Co., Ltd., at Flin Flon, Manitoba; the most northerly hydro-electric station in the world, being located on the fringe of the Arctic Circle.

Adjustable Blade Runner for Experimental Turbine. One-piece castings up to 16 ft. diameter have welded on overlays to resist abrasion by rushing water. Smaller runners have been cast of alloy steel.

On these units the throat ring has been prewelded with a chrome-nickel alloy around the circumference for a width of approximately 9 in. at the region of discharge from runner tips. (This is the same part of the draft tube as was covered with stainless austenitic steel plate in the Queenston turbine described on page 47.) After the metal had been deposited, the surfaces were carefully dressed to correct contour by grinding, and subsequently polished. Runners for these units, as before mentioned, were also prewelded with the same chrome-nickel alloy.

These two instances of prewelding are cited because of the large size of the units, as well as the fact that both plants may operate at times under hydraulic conditions which aggravate, rather than diminish, the tendency of pitting on certain areas of the runner, and on portions of the water passage immediately adjacent thereto.

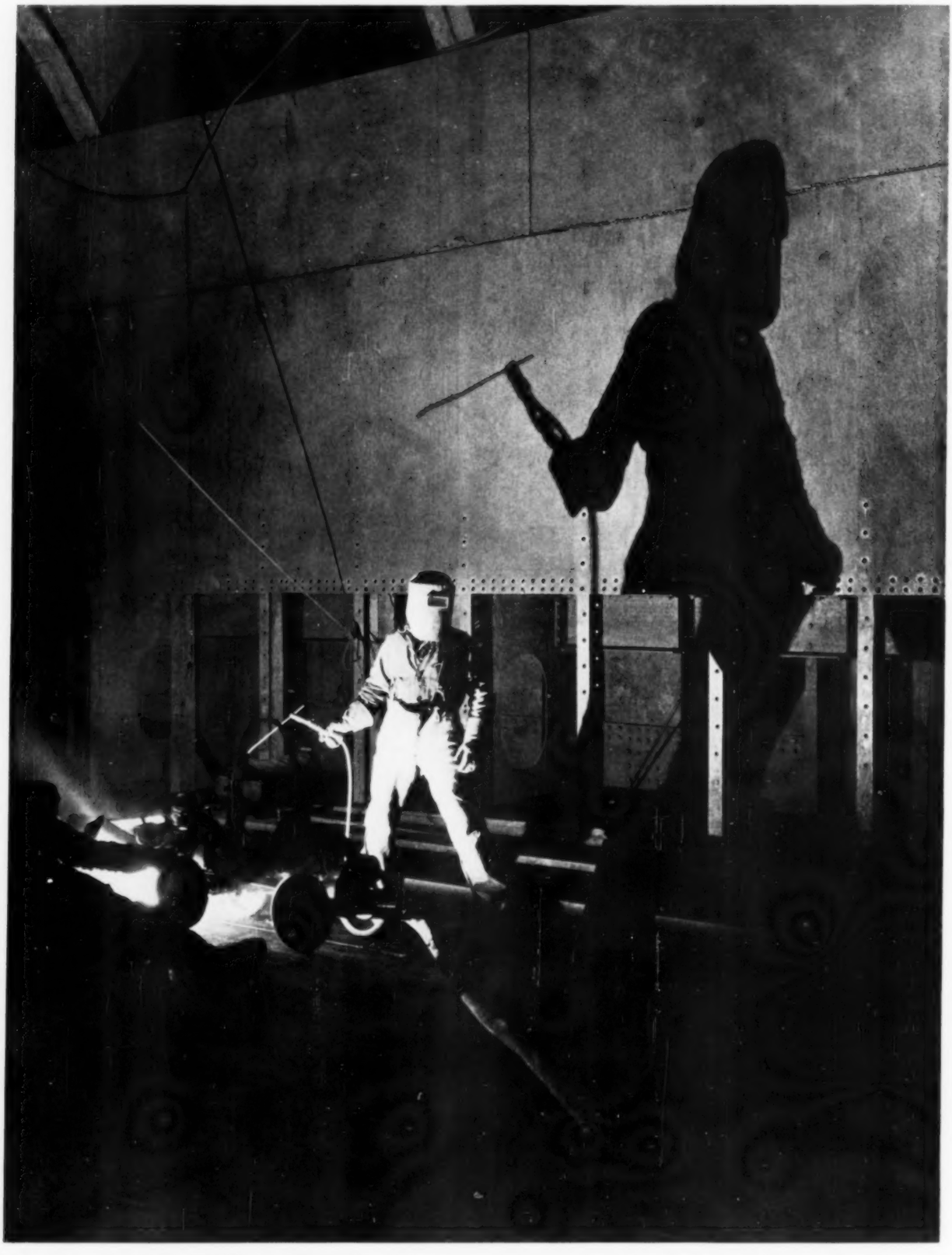
Numerous other instances might be mentioned, but sufficient has been given to indicate that the alert and progressive manufacturer is alive to the advances being made in the field of metallurgy and, wherever possible, is making the fullest use of the materials now obtainable.

Shop Assembly of 58,000-hp. Turbine and Its Cast Steel Casing. Alloy steel was used for all joint bolts, link pins, keys and shafts. It was also equipped with a runner of the high speed propeller type, which had high chrome-nickel alloy welded on those surfaces where pitting occurs

But until the customer is educated to the point where he is willing to pay for this additional security (which, in a sense, is only another form of insurance), progress is bound to be somewhat slow.

In this advance, however, we can take to heart the example of the automotive industry. It has worked wonders in pioneering processes and apparatus to obtain uniform results at a minimum of cost. In fact, were it not for this key industry, it is reasonable to suppose that many of the alloy steels which are now produced on a commercial basis, and therefore within the range of manufacturers who require only limited quantities at irregular intervals, would not be procurable except at a considerable increase in price and slower delivery.

A broader distribution among the purchasers and users of machinery of the knowledge about improved metals will give increased impetus to the movements we have been discussing. This knowledge is being distributed through the largely attended extension courses inaugurated by our leading universities as well as the constantly increasing membership in the A.S.S.T. and other institutions formed for the promotion and study of the composition and thermal treatment of steels. This is sufficient evidence that the public is alive to the necessity of not only acquiring a working knowledge of this science, but of so ordering their reading and spare time activities that they will be in constant touch with the progress and discoveries being made throughout the world.



Welding Bottom in Ore Carrier With Electronic Tornado. Courtesy Lincoln Electric Co.

Recommended Practice ....

Committee Release part 2

OUTLINE OF WELDING AND ALLIED PROCESSES

By F. T. Llewellyn

WHILE the process of cutting ferrous metals by means of a gas flame is foreign in function to that of welding, it is included in this outline because it is performed with the aid of a torch whose construction, fuel and operation are very similar to those employed in welding. There are differences, however.

The cutting torch is provided with an additional third passage for the transmission of oxygen under high pressure, for it is the chemical combination of oxygen with the metal, and not the heat of the flame, that does the cutting. Moreover, while in gas welding practically the only gases used are oxygen and acetylene, in gas cutting the acetylene may be replaced by a cheaper fuel such as hydrogen or hydro-carbon gases.

In the cutting process a small spot of the metal to be cut is first heated to a red temperature under a neutral flame. The high pressure oxygen valve is then opened and this causes a jet of almost pure oxygen to impinge on the glowing metal. The result is a chemical combination of iron and oxygen to form iron oxide, thus creating a depression that soon becomes a slit (kerf) in the metal. The pressure of the oxygen blows the oxide away as fast as it is formed.

The popular use of the term "burning" as applied to this process is not quite correct, for only the oxide removed is burned. Some of the metal melts and is carried out into the slag unburned. The remaining edges of the base metal are tempered to a depth that seldom exceeds ⅛ in.

For greatest efficiency the oxygen pressure and the angle at which the jet should be aligned vary with the thickness and grade of the metal to be cut. Makers of gas cutting equipment have prepared charts giving the result of different combinations of pressure and angle. Steel containing a high percentage of carbon should be preheated prior to cutting.

The cutting of cast iron requires a sidewise oscillatory motion of the jet, and certain flame adjustments. In the cutting of fabricated parts that will later be subjected to major stress, as in the case of structural and machine steel parts, sidewise oscillation should be avoided. Any irregularity results in notches which may soon develop into cracks. Regularity of motion and smooth cuts may be secured by the use.

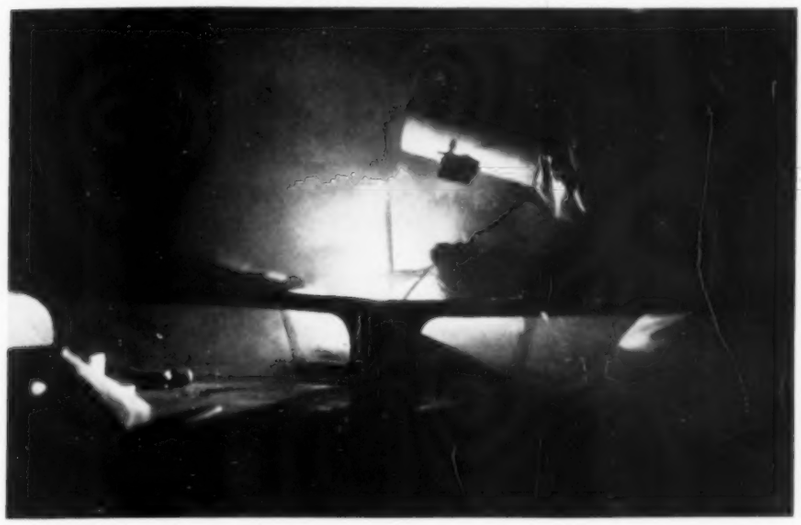
of an automatic cutting machine, or by the employment of a template along whose edge the torch tip is guided. Tests indicate that steel parts that have been smoothly cut by this process are stronger than if sheared, and almost as strong as if machined.

The largest steel ingots or other similar objects can be rough-sheared by the combination of a cutting torch and an "oxygen lance". The lance is a simple device that may also be used alone for piercing large masses of slag, stone, cement and iron. It consists essentially of a nozzle composed of a suitable length of $\frac{1}{8}$ or $\frac{1}{4}$-in. steel pipe connected by means of strong hose to an adequate supply of compressed oxygen. For reasons of safety and economy certain accessories are desirable. A manifold regulator maintains the volume of oxygen at a moderate pressure. Woven hose with no wire winding should be employed, and care should be taken that it has not been used for other purposes on account of dangerous greases that may remain. A 3-ft. length of 1-in. extra strong bent pipe, inserted between the nozzle pipe and the hose, serves as a handle. In operating the lance a spot on the mass to be pierced is made red hot by any convenient means and on this spot is blown an excess of oxygen which, by combining with the iron, rapidly bores through the mass. The end of the nozzle pipe is heated and consumed as the hole deepens.

Arc Welding. The discovery of the practical possibilities of the electric arc process of fusion welding arose from the fortuitous fact that in the process of wire drawing enough lubricant remains on the wire to furnish the flux needed to make a weld with it. The industrial development of the arc process originated during the World War. There are many methods of applying the process which differ in detail, but in all of them an arc is struck between an electrode and the parts to be welded, thereby generating intense heat which fuses them and the additional weld metal used.

Alternating current is employed to some extent, notably in erection work where the greater portability of its light transformer equipment is advantageous, but for most other purposes it has been found preferable to use

Demolishing a 52-Ton Rock Crusher Bowl of Cast Iron With an Oxy-Acetylene Cutting Blowpipe. Courtesy Linde Air Products Company



Welding Interior Joint on a Light Frame With Carbon Arc and Welding Wire. Courtesy Lincoln Electric Co.

direct current despite the greater weight of its motor-generator equipment. Generators may be of constant potential, constant energy or constant current type. When thick medium steel is to be welded by direct current the base metal usually serves as the positive pole, the electrode forming the negative pole, for the reason that greater heat is generated at the positive pole. If the base metal is thin or of a high carbon or alloy grade the polarity is generally reversed.

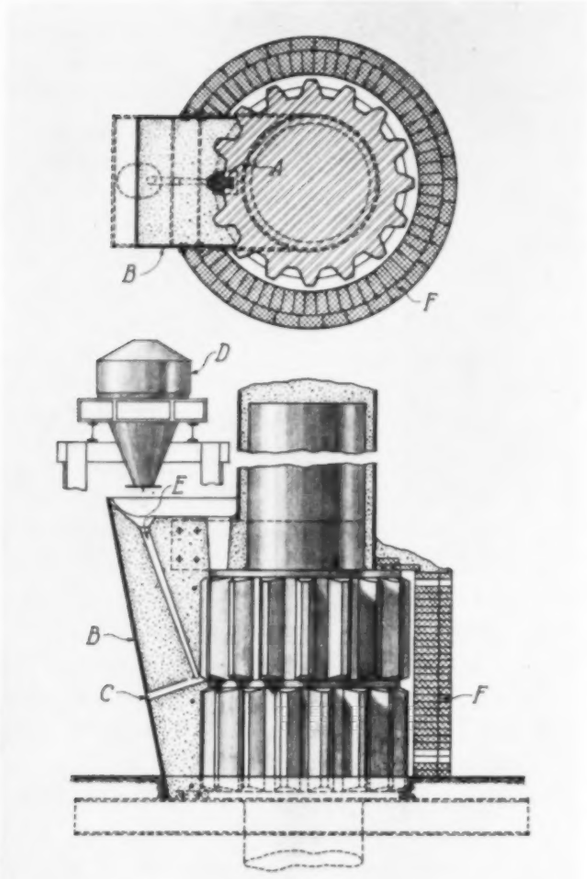
Work may be performed either manually or by automatic machines having one or more welding heads. In full-automatic machines both travel and feed are controlled mechanically. In semi-automatic machines only the feed is controlled mechanically. Manual welds may be used in any position.

In the carbon arc process the electrode is composed of carbon. It is utilized only to produce heat, the weld metal being either taken from surplus base metal or supplied independently by a welding rod manipulated similarly to that used in gas welding.

In the metal arc process, which is the more prevalent at the present time, the electrode is composed of a suitable grade of metal which serves as one pole of the circuit and at the same time provides weld metal by the progressive melting of its end. In manual operation the electrode is clipped into a holder and the operator uses only one hand.

The weld metal, whether supplied independently or by the electrode, is commonly furnished in the form of wire of substantially the same grade as that of the parts to be welded. In manual arc welding common diameters of wire are $\frac{5}{32}$ and $\frac{3}{16}$ in. These sizes require about 160 and 200 amp. of current respectively, the voltage being about 20 in both instances. If automatic machines are employed it is feasible to use larger diameters, higher currents, and consequently greater speed. Arc welds having a depth of not over $\frac{3}{8}$ in. are usually made in one layer. If $\frac{1}{2}$-in. plate is welded, two layers are common practice; three or more are used for $\frac{3}{4}$-in. or more. If the joint is of a "rigid" type it is advantageous to hammer (peen) the inner layers lightly. The arc weld may be of butt or lap type and of any desired form, and it can make a fillet weld of any size.

There are several special processes of arc welding which permit the use of larger diameters of welding rod, higher current and greater speed than are feasible when bare wire is used in conjunction with the ordinary process. These special processes also aim to produce a weld having increased ductility. In one such process both electrode and deposited metal are shielded from oxidation by the maintenance of an atmosphere of hydrogen, water gas, alcohol vapor or other reducing medium around the arc. In the "electronic tornado" process similar shielding is provided together with the superimposing of a strong magnetic field on a carbon arc which, while appearing to give it a gyratory motion, permits the arc to function without essential



Replacing a Broken Tooth on Blowing Mill Pinion With Thermit. A slot is cut under the missing tooth and a wax pattern A formed to exact shape of desired weld. Mold box B is then erected and tamped with sand, leaving passages as shown. Oil burner flame blowing through heating gate C melts wax mold and preheats steel where weld is to be made. The heating gate is plugged and thermit steel tapped from crucible D into the prepared cavity through pouring gate E. Meanwhile, entire pinion has been mildly preheated by flames playing inside temporary brick furnace FF. Courtesy Metal & Thermit Corporation

disturbance. In another recent process a bare metal electrode plows with oscillating motion through a thick mass of fluxing material which serves both as a shield for the arc and as a blanket to permit the metal already deposited to cool slowly. These special processes are usually applied by means of automatic machines which operate to greatest advantage on flat work.

In conjunction with both ordinary and special processes of arc welding the wire may be coated with either a slagging or a fluxing medium which cooperates in permitting the use of larger welding rods, higher current, greater speed, and usually increased ductility. Such wire is said to be "fluxed." A fluxed type of wire is essential if alternating current be used. If enveloped by a fabric which either serves to retain the flux or which has itself been impregnated with a suitable flux or alloy, the wire is said to be "covered".

Atomic hydrogen welding embraces features of both gas and arc processes. While an electric arc is the initial source of heat, the base metal forms no part of the electric circuit but is fused by heat from a so-called flame, as in the gas process. To be specific: a fine jet of hydrogen is forced through an alternating arc formed between two tungsten electrodes. The high temperature of the arc momentarily breaks down the hydrogen molecules into atoms which, after passing through the arc, recombine into molecules and in so doing give up the heat absorbed during dissociation. The result is a "flame" of hydrogen whose temperature is higher than that of any other known flame. Weld metal is usually supplied independently, as in the gas process, but for some purposes it is taken from surplus base metal. The magnitude of the current is limited by the combustibility of the tungsten electrodes, and hence the process is largely employed on thin materials. In the union of such materials as suit the process, a quality of weld results that is both sound and smooth. Alloys, such as high chromium and high nickel steels, are readily welded by this process.

Thermit Welding. This originated with a discovery made in Germany, about 1900, by Dr. Hans Goldschmidt, who found that if a mixture of metallic oxide and finely divided aluminum were ignited at one spot, the two materials, reacting chemically, would liberate much heat (exothermic reaction) and the reaction would progress throughout the mixture, thereby converting it into two new materials, a superheated mass of the metal itself and a slag composed of molten aluminum oxide (alumina).

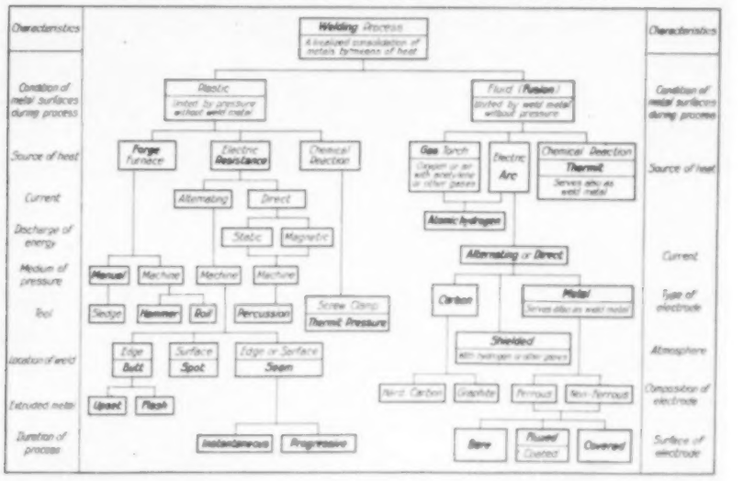
He further found the reaction would progress so rapidly that a ton of material could be converted from a cold mixture in half a minute. Later the most suitable kind of iron oxide (Fe_3O_4), the best size of its flakes, and the proper percentage of its fines for use in welding steel were developed (known as "thermit mixture" or, more briefly, "thermit") as well as the possibilities resulting from the addition to a "thermit steel" mixture of such elements as chromium, nickel, vanadium, and manganese.

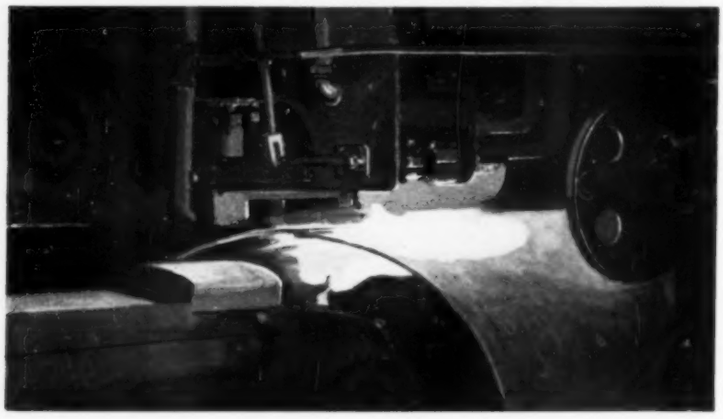
The thermit process as practiced today is properly termed "thermit fusion". Parts to be united are separated or cut back a space whose extent depends on their size, and the surfaces are thoroughly cleaned by sand-blast or otherwise. Usually this space is given the form of a parallel-sided gap cut by means of a gas torch, the slight layer of oxide resulting from the cutting process being apparently beneficial. Between and around the parts a wax pattern is formed whose shape is that of the reinforcement desired. A sheet iron box is then placed around this pattern with a space between it and the pattern, and when the wax has hardened sand is rammed into the space, provision being made for a proper number of risers and pouring and heating gates. Then the wax is melted by directing a flame of compressed air and liquid fuel into each heating gate, and as it flows away it leaves clear the space to be occupied later by the thermit steel. Heat is continued so as to dry out the sand mold and to bring the parts to be united to a red temperature. If multiple sections are to be welded a two-part mold and a special wooden pattern may be substituted for the box and the wax.

Meanwhile a proper thermit has been placed in a crucible supported over a pouring gate or gates, and when the work is ready the mixture is ignited. In about half a minute the reaction is complete and the thermit steel is then tapped from the bottom of the crucible into the pouring gate. The superheated metal flows around and between the hot parts to be united, thoroughly fusing with their surfaces and welding them into one homogeneous mass, while the molten alumina slag (coming last from the crucible) overflows into a basin on top of the mold.

Heat Treatment of Welds and Welded Parts. Many products that have been welded by the several processes described are used for purposes requiring subsequent heat treatment. Results indicate that the fused metal is certainly not injured by such treatment, although further investigation is needed to determine the extent to which it is improved. Probably the *grade* of weld metal used in fusion welding has an important effect on the results of subsequent heat treatment. The indications are that annealing does not change the grain structure of ordinary weld metal to any appreciable extent, and that its influence on alloy weld metal, while greater

CHART CLASSIFYING THE PRINCIPAL WELDING PROCESSES





Heating a Portion of the Seam Prior to Hammer Welding. The diagrams below indicate how intense flames of burning gas are directed simultaneously on the overlapped edges, both inside and out. Just at the left of the flames are shown the anvil and power-driven hammer, ready to move forward and forge the weld

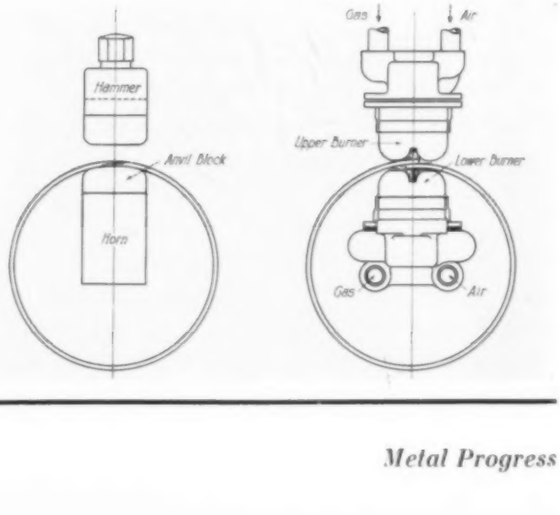
than on the commoner grades, does not result in more than 12 to 15% increase in ductility. Annealing is applied with substantial benefit, however, to a number of welded objects for the purpose of relieving unequal cooling stresses.

Testing. Welded specimens may be tested by destructive methods in the same manner as are base metal specimens, but their yield point and ductility are not readily determinable by these means. Since the yield point of the weld metal deposited by fusion is frequently higher than that of the base metal which has been united, necking will occur in that part of the test piece comprised of adjacent base metal before the weld metal is fully stretched. Yield point and ductility can be ascertained by testing specimens made entirely of virgin weld metal, but such tests do not necessarily reflect the character of the welded assembly. Several forms of bend test have been developed with a view to confining the part measured to the weld metal, and there are grounds for expecting that acceptable standards for so doing will be established in the near future.

The soundness of a weld may be determined non-destructively in various ways. For laboratory use, electrical, magnetic, and X-ray methods are employed. In the electrical method the variation in resistance to passage of current is used to detect the location and magnitude of a defect within the weld. In one magnetic method an oscillograph records any difference in the composition of the specimen being tested as compared with that of another specimen whose quality has already been determined.

Testing methods used in the shop and field are of a more qualitative sort. The nature and regularity of the crackling sound produced by a welding arc have been found to reflect the uniformity of a weld. In all fusion processes visual inspection of the exterior of the weld has real value as an indication of its integrity. The interior of a weld may be explored by means of a gas torch, the portion so melted being subsequently re-welded. A stethoscope may be employed to detect by means of sound the location and extent of any non-homogeneous portion of the weld. Much emphasis is placed on the assurance of weld quality secured by periodical qualification of operators, wherein they are called upon to weld specimens which must develop predetermined unit strength when tested to destruction. Proof tests may sometimes be applied to the finished work by observing its behavior when subjected to a load of 1½ to 2 times that for which it was designed.

Physical Properties. The strength and ductility of objects welded by *(Cont. on page 104)*



By J. Howard Williams

BRONZE . . MELTED ECONOMICALLY IN HIGH FREQUENCY FURNACE

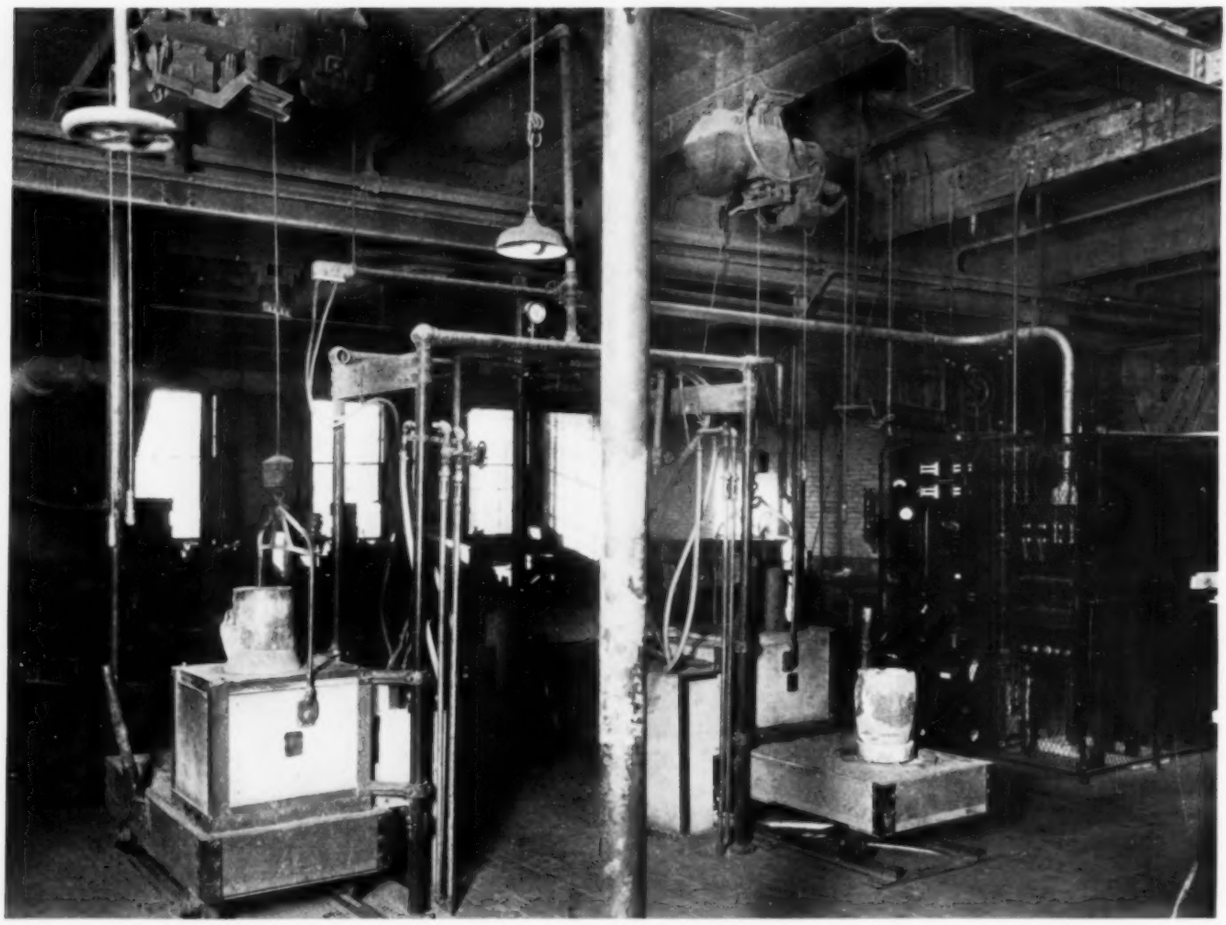
AN INTERESTING application of the high-temperature induction furnace to bronze foundry work has recently been made in the Providence, R. I., plant of General Fire Extinguisher Co. Primarily the molten metal is intended for small castings for Grinnell sprinkler heads, of which one is used on every outlet in each fire protection system sold or installed by the Grinnell Co. (The Grinnell Co. is an engineering organization marketing nearly every class of industrial and power piping, including heating, humidifying and refrigerating units, and fire protection and sprinkler systems. General Fire Extinguisher Co. is the manufacturing organization for the latter products.)

These new furnaces are located near a battery of pit furnaces, which they supersede. The foundry production is of highest quality bronze castings, of small size, and naturally requires careful control of temperature, alloy composition and gas content. All these requirements have been met, economically, and in a most gratifying manner.

The entire installation is shown in the view on page 58. Two furnace units are provided, both shown in normal working position, but either can be lifted by an overhead electrical hoist, the furnace being guided by two vertical pillars set alongside. The shell, in fact, is a bottomless box or cover, and as it rises it leaves the crucible undisturbed. Each furnace unit is supported on a wooden-framed car which also carries two crucibles resting on fireclay pedestals and a thick sand bottom. While one crucible is under heat, the other is being made ready for the next. Action is so rapid that only one furnace is used at a time to supply a sizable molding floor with hot metal, the entire power being consumed therein, and the other furnace kept as a spare.

As is doubtless well known, the furnace consists of a thin refractory lining around which is a water-cooled induction coil. This unit is encased in a rectangular receptacle of transite board reinforced with bronze members. The funnel-shaped piece on the top is a short stack used for holding the excess metal protruding above the crucible top before it is melted down.

Electrical current is brought to the furnace



Bronze Melting Equipment Is Quite Compact, Consisting of Two Furnace Units and One Switchboard and Condenser Bank.

by flexible cables leading from a conduit outlet overhead. Water inlet and outlet is by means of hose connections. Furnace efficiency may be seriously lowered by the induction of stray currents in furnace casing, car-bottom and vertical guides, but this is avoided by proper sectionalization of the metal in these auxiliary structures.

A close-up view of a furnace under power is shown opposite. On the same car-bottom is also the next batch made ready for transfer as soon as that in the first is melted. Crucibles are loaded as quickly as possible after pouring in order that the batch may absorb the heat of the crucible that might otherwise be lost. When a heat is ready, the operator lifts the furnace, rolls the car until it comes against rail stops, then lowers the furnace over the new batch. The little chimney is filled by the furnace attendant with the excess metal while the molders are pouring off, the excess being that part which will not enter the crucible until melting takes up the voids in the solid charge.

Another view shows the furnace in raised position with a pair of workmen removing a crucible, also another crucible in the background, just under a furnace shell, loaded and made ready for melting.

Number 70 crucibles are used and are loaded with 190 lb. of bronze. This material is heated to 2,300° F. and poured directly into the molds from the crucible in which it is melted. Charcoal is used to blanket the metal and is put in the furnace just at the time of melting.

Melting time varies with the kind of crucible, its age and the amount of heat it con-

tains from the previous heat. The average time for the first two heats is 18 min., and subsequent heats are at the rate of about 16 min. each, when under continuous operation.

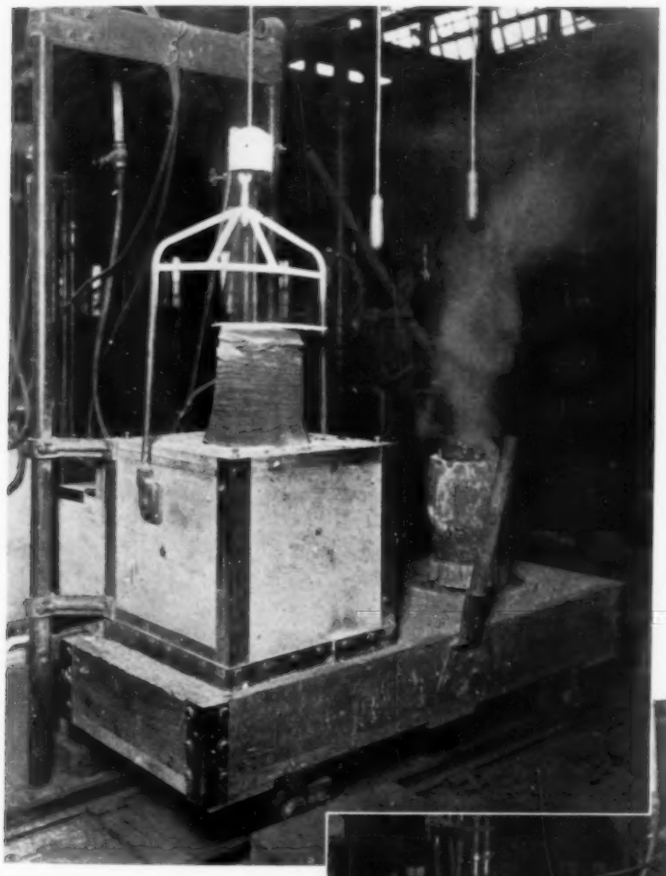
Conditions around the furnaces are as comfortable as around a machine tool. A person's hand can be held with comfort against any part of the exterior of the hot furnace at any time.

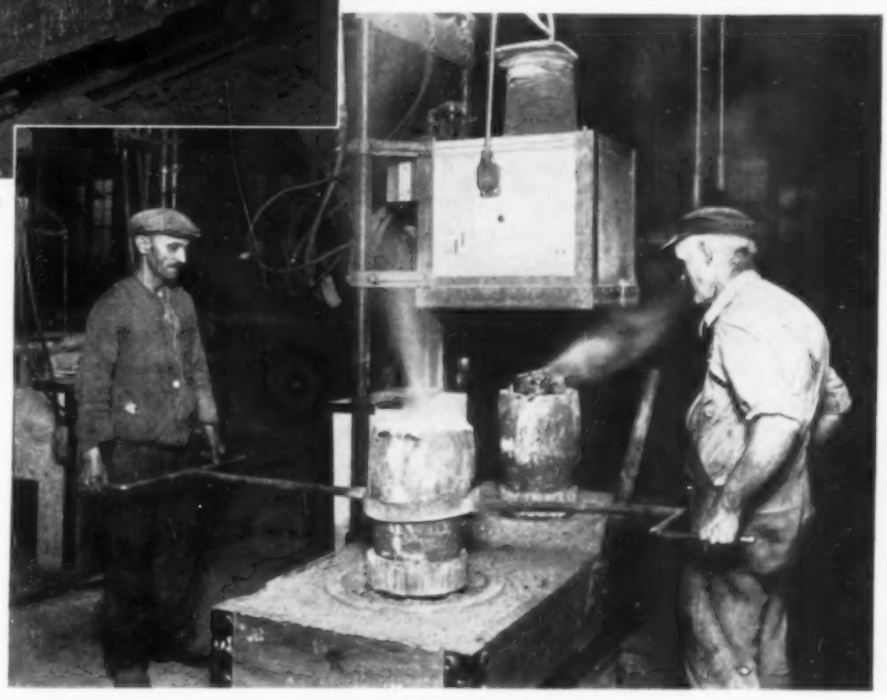
Should there be a delay at the molding machines and it be desirable to hold a heat, it can be done readily by turning off the power and again applying it a short time before the metal is poured. Should the metal on examination be found at too low a temperature for pouring, it is raised by a short application of power; heat is quickly generated within the metal.

Due to inherent phenomena in this type of furnace, the metal is more thoroughly mixed than in any other, as the metal itself is agitated by induction and appears to boil very fast as soon as it is melted.

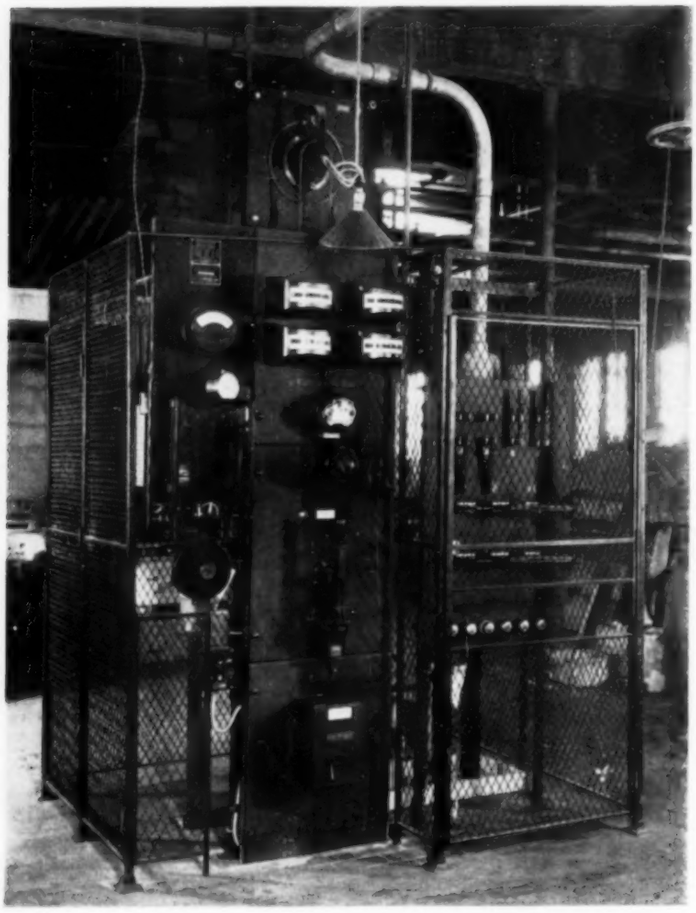
The quality of metal obtained by this process is very high, as air has little or no opportunity to mix with the metal. There are no furnace gases to be absorbed.

Heat is generated by electrical resistance in the metal charge, rather than by gas or coke flames outside the crucible; consequently the metal is hotter than the crucible, rather than vice versa, and the crucible life is cor-





Furnace Shell Is Lowered Over One Crucible and Heats It. When the one charge is hot enough for pouring, the furnace shell is raised, the car moved forward, the shell lowered over the other crucible, and the liquid metal carried to the molds and poured. Hot empty crucible is then reloaded with measured amount of bronze.



Electrical Equipment and Switchboard Require Little Space. Motor-generator set is on another floor, controlled by pushbuttons at lower left.

respondingly prolonged over that expected in pit melting.

Little metal is lost by vaporization, as there is no draft in the furnace and the metal is poured immediately after melting. The analysis of metal after melting is almost identical with that before heating, and consequently alloys can be formulated with precision.

These furnaces, built by Ajax Electrothermic Corp., Trenton, N. J., are consequently not only new in type but unique in design. The auxiliary electrical equipment consists of a 100-kva. high frequency motor-generator set, operating at a frequency of 480 cycles and 1,000 volts. The motor is a standard design, squirrel-cage type, 150 hp., 60 cycle, 3 phase, 550 volts, 1,800 r.p.m. The generator is operated single phase and loaded with condensers to obtain a power factor of from 95 to 100%.

The switchboard equipment, shown above, consists of three small panels. That portion at the center and left is the generator panel with voltage regulator, power factor indicator, watt, volt and current meters with generator and exciter switches. At the left, below the circular rheostat, is shown a pushbutton station for starting the generator, which is on another floor about 200 ft. away. That portion of the switchboard behind the wire door on the right is for distributing current to one or the other furnace as desired, and for controlling the condensers.

The advantages of the equipment are many, the principal ones being low metal loss, quick melting, unvarying product, uniform temperature, comfortable working conditions, cleanliness, ability to obtain one or more additional heats on short notice, quick change from one alloy to another without endangering the analysis, immediate shutdown, no fuel or ashes to handle, freedom from objectionable gases, neatness in appearance and long life of crucibles.

MANY SIZES AND PARTS HEAT TREATED BY . . BROWN AND SHARPE

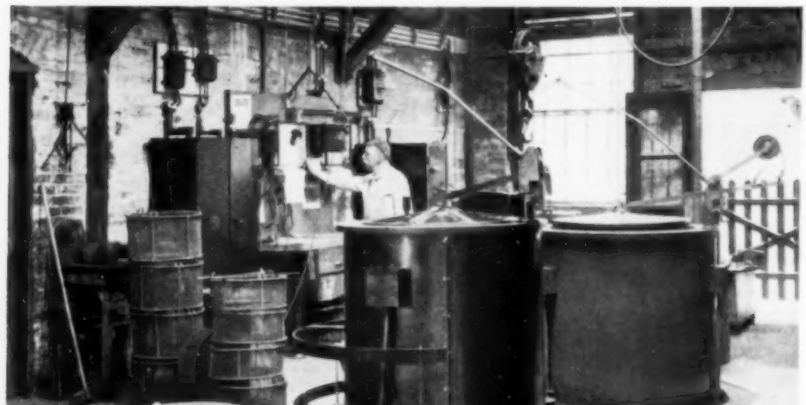
By E. W. Freeman

A VISITOR at Brown & Sharpe Mfg. Co. plant in Providence would see batteries of furnaces in the central hardening department, groups of diverse equipment such as illustrated on the following pages. He might raise the question: "Why such a variety of heat treating furnaces?" and, in turn, another: "Why is not large, continuous equipment more economical to handle such a large volume of work?"

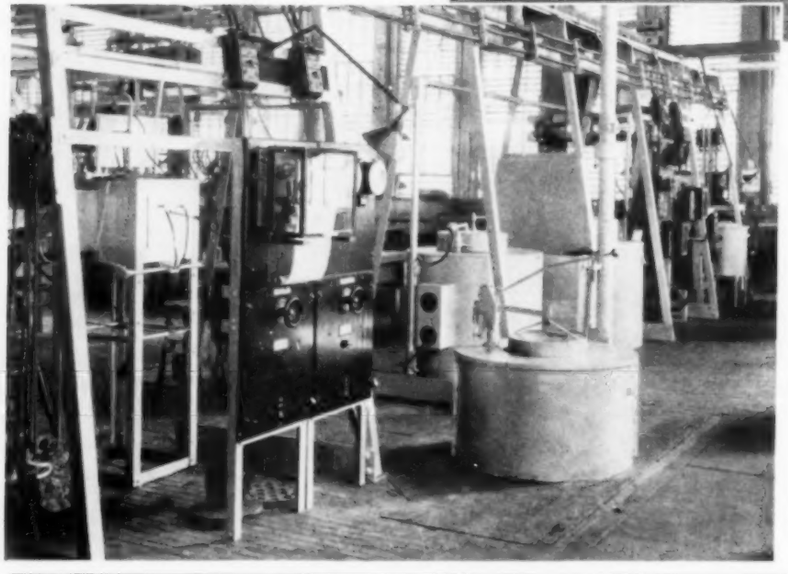
The answer is found not in the tonnage of work being handled, but in the extraordinary variety. Most persons who know much about Brown & Sharpe think of the company as a manufacturer of machines and tools. But when the individual items are listed, he finds that there are four distinct lines of machine tools, comprising about 100 types and sizes; over 2,300 different machinists' tools; and 35 styles (including about 4,000 sizes) of milling and gear cutters. In addition to this output, well known to the metal industries, the company also does a nice business in such specialties as hair clippers and sewing machines. Production work comprises the bulk of the tonnage treated; nevertheless the hardening room receives its share of work for the gear department; it also undertakes special work for the machine, tool and cutter departments from time to time.

In the light of this variety and number of items manufactured, the reasons for installing several types of hardening equipment are more easily understood. This was brought forcibly to our attention in 1928 when we decided to modernize the hardening equipment. The consideration of primary importance in the selection of furnaces and auxiliaries was found to be the *type* of work to be handled.

In a single product plant, such as a screw machine manufacturer with large production, a relatively simple problem is to be solved. The quantity of similar work is large, and quantity can be taken care of by the multiplication of individual heat treating units. The automobile factory is another type of plant where the production and product remain constant for considerable periods of time. The selection of heat treating equipment is relatively simple.



because production demands can be determined in advance, and special purpose furnaces can be installed. The machine tool plant, on the other hand, has no enormous quantity of similar pieces. When you add to the manufacture of milling machines, gear cutters, automatic screw machines and grinding machines, such miscellaneous equipment as milling cutters, sewing machine parts, hair clippers, scales and micrometers, you have a very complicated problem to pick out the correct type of equipment for the hardening room. As we had to take a varied product, we decided that large continuous equipment was not adapted to our needs. Batch type furnaces were the alternative. For the sake of description, the equipment



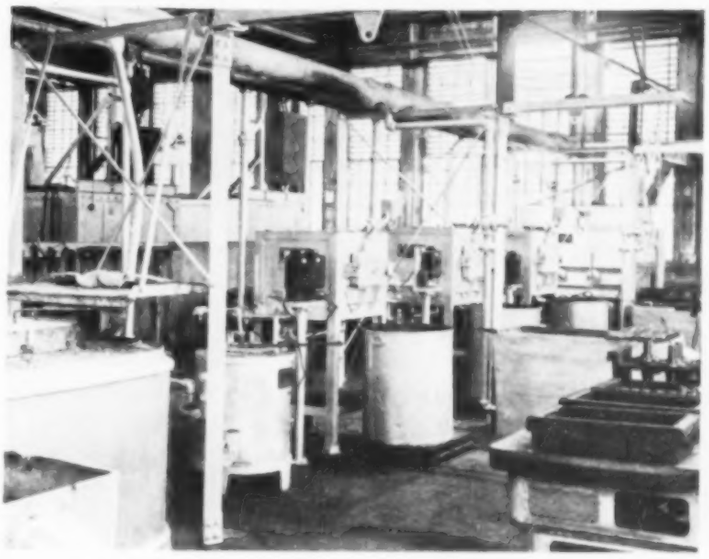
At Top: A Pair of Tempering Furnaces of the Convection Type. Basket containers are standard, handled by three-fingered hooks and overhead crane.

At Center: Control Board for Carburizing and Annealing Furnaces Shown on Pages 64 and 65.

At Left: Hump Furnace, With One Small and Two Large Electric Pots in Background. Note electric cables and control.

may be divided into five classes:

1. Carburizing and annealing furnaces,
2. Pot furnaces,
3. Small furnaces,
4. Tempering furnaces, and
5. High speed furnaces.



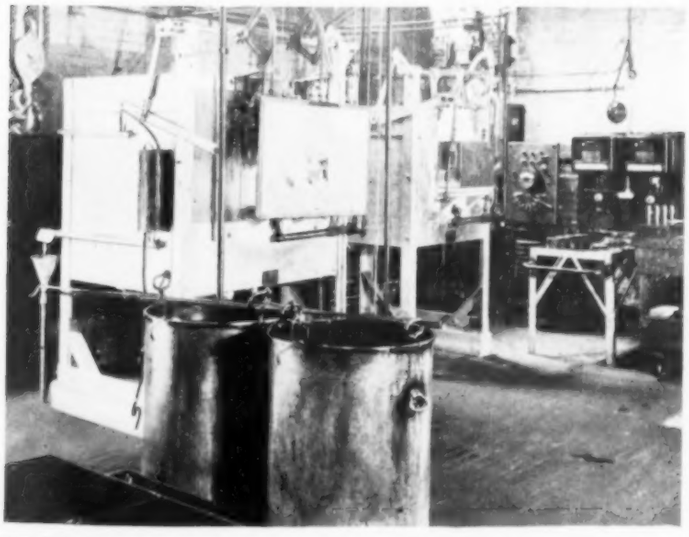
Carburizing and Annealing

The multitudinous carburizing and annealing requirements are taken care of by the eight box-type electric furnaces shown in the views on pages 64 and 65. Three of these furnaces are set so their hearths are flush with the floor. This simplifies loading and unloading, as heavy boxes and clamped work can be placed in the furnace readily by means of dolly trucks.

The other five furnaces are of standard construction with metal hearths and ribbon elements on two sides and bottom. They are used for smaller boxes which can be handled by one man.

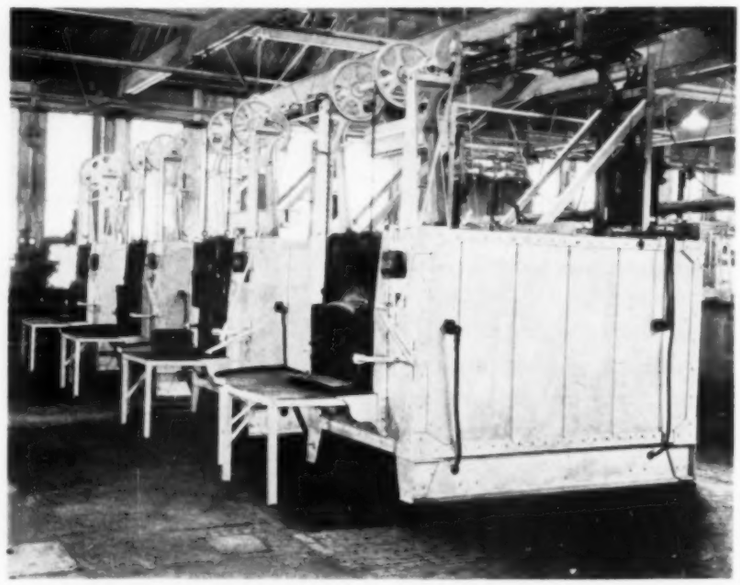
Carburizing boxes are standardized in shape and size to as great an extent as possible, having in mind the variety in size and shape of pieces to be treated. These standardized boxes are all made of nickel-chromium alloys and to date we have not observed the expected difference in lasting qualities between alloys with a considerable variation in cost. Some operations call for quenching these boxes in cold water immediately after they have been withdrawn from the furnace at 1,500° F., so it can be seen that they are subject to drastic stress. We also have several fabricated boxes in use.

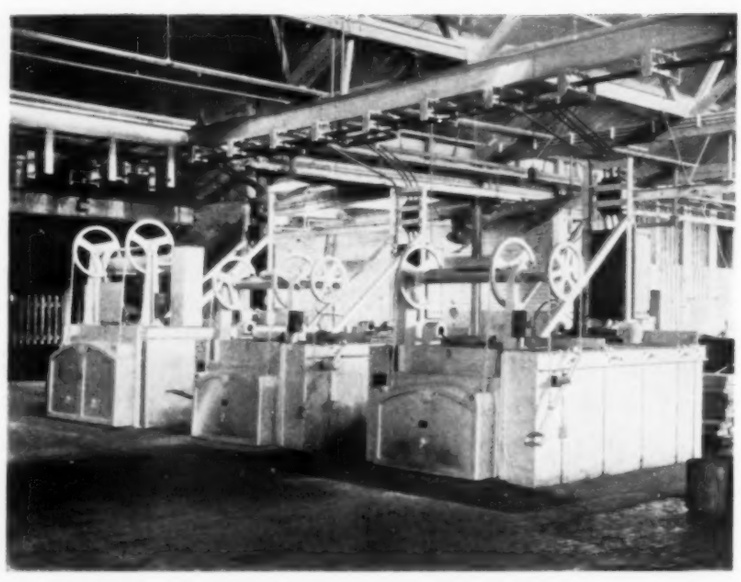
Carburizing furnaces are loaded before the workmen leave at 5 p. m., and at a predetermined hour a time switch turns on the power and the furnaces are brought up to heat and held there under automatic control. When the men come in at 7 a. m. the work is ready to be withdrawn from the furnace and quenched or allowed to cool in the boxes. Immediately after removing the night charge, the furnaces are again loaded, so that another heat is obtained during the day. By this schedule, we get 24-hr. furnace operation with one shift of workmen.



At Top of Page Is Shown a Row of Five Gas-Fired Furnaces for Miscellaneous Small Work. At left are gas-fired furnaces for high speed steel—one a preheat and the other a high heat. Note pyrometer cold end construction on side of latter.

Brown & Sharpe Annealing and Carburizing Furnaces. On this page are batteries of electric furnaces, one with raised hearth and the other with hearth flush with floor. On page 65 is a gas-fired pusher type furnace, used primarily for annealing small cast iron parts.





We also operate two rotary gas carburizing machines for small parts such as nuts, bolts and screws. The city gas must be fortified with compound, but as this acts as a buffer for the work, its presence is not objectionable. When these rotary furnaces are dumped, the work and compound fall on a short wire-mesh chute which ends in the quenching bath. The work slides down the chute, but the compound falls through into a box.

Pot Furnaces. Three elliptical and four round pot furnaces have been installed. They are equipped for either cyanide or lead baths, and at the present time, two of the elliptical furnaces and one of the round furnaces are filled with cyanide for case hardening.

These furnaces have alloy pots and are electrically heated. Lead containers have lasted two years; for cyanide they last about six months. We have found that the heating elements in the round pot furnaces last much longer than those in the elliptical furnaces. In fact, we have not yet replaced an element in one of these round furnaces, except due to an accident not connected with normal operation.

In addition to these seven electric pots, we have one small gas-fired furnace equipped with a steel pot which we use for experimental purposes with various salts.

Small Furnaces. Furnaces in this classification are used for miscellaneous work such as tool steel cutters, arbors, shafts or cams.

Five of them are small box furnaces, heated by gas. Their hearths vary from about 12x18 in. to 18x48 in.

The other five furnaces are round vertical electric furnaces of the "hump" type, and their sizes vary from 5½x14 in. to 14x48 in. The views on page 63 show this installation, and give some idea of the means we have taken to insure low upkeep on such auxiliaries as fuel supply, electric mains and control equipment and pyrometers.

Tempering Furnaces. Over 80% of the work needing tempering is drawn in forced air flow convection furnaces. Four of these units

are operated, ranging in size from 14x16 in. to 20x26 in. hearth area.

Work which is too large for these furnaces is drawn in box-type electric furnaces described under the first classification.

High Speed Steel Furnaces. High speed steel is heat treated at Brown & Sharpe in oil-fired units, and the drawing is done in forced air flow convection furnaces. We did not change the equipment in this division when we were rebuilding the rest of the hardening room, as we felt that new developments in high speed steel furnaces were imminent. At the time we did not feel that the electric furnace for such high temperatures was out of the experimental stage, and consequently, we did not want to tie up a considerable sum of money in them. These furnaces, however, are the sole survivors of the coke- and oil-fired equipment described by *American Machinist,* April 28 and May 5, 1927. These articles may be consulted to get a good idea of conditions as they existed in comparatively recent time.

Control Equipment. Every furnace in the hardening department is equipped with a pyrometer of the potentiometer type.

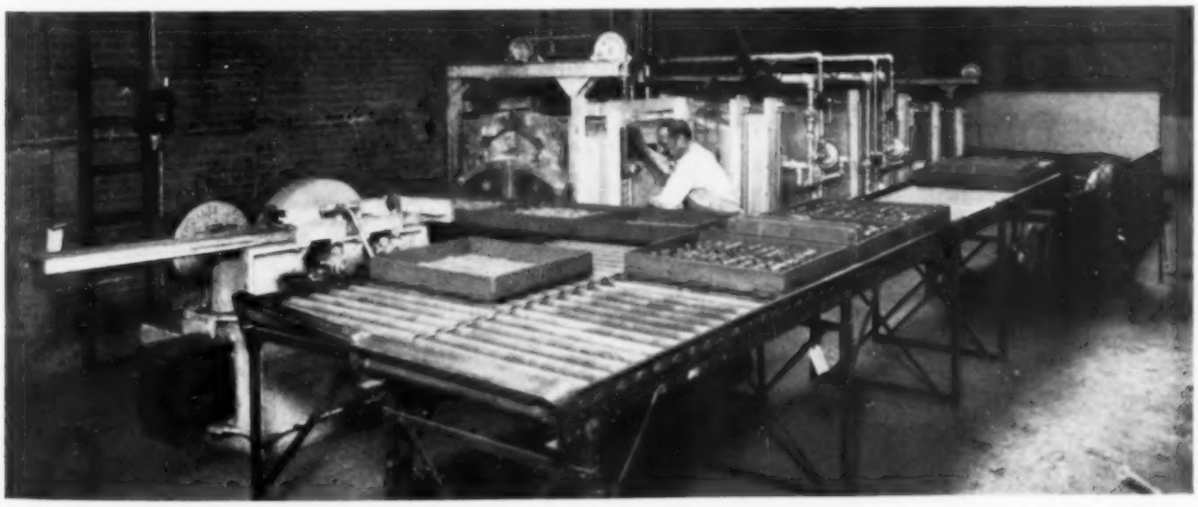
Automatic temperature control is installed on all of the production units. The box-type furnaces and the drawing furnaces are equipped with recording controllers, the lead and cyanide pot furnaces with non-indicating controllers and the high speed furnaces are equipped with indicating controllers.

We have no trouble in maintaining these instruments and it is very seldom that the factory service men find any work to do when they call at our plant.

Need For Skilled Workmen

The equipment described above was installed during a slack period, and as the volume of work increased, the new equipment took care of this increase without the aid of extra men. This resulted in a marked economy in labor costs. Another saving comes from the circumstance that all equipment is automatically put on power so it is up to heat and ready for production when the men arrive at their stations in the morning.

Working conditions have been greatly improved. Many operations, which formerly required a high degree of skill obtained only by long practice, can now be done by the average hardener. This makes us less dependent upon the individual workman. However, it does not mean that expert workmen have been eliminated. Notwithstanding all of the modern furnace equipment, electric and other sensitive indicating and recording instruments, and the versatile instruments for testing the hardness of parts as they come from the various operations, the day of the skilled workman has not passed — although the skill of today is largely based upon the more scientific study made possible by these perfected instruments.



Courtesy Republic Steel Corp

. . . EDITORIAL . . .

AT THE END of the year it is customary for an individual to look back and appraise his accomplishments, if any, and to make certain resolutions for his future conduct. Retrospection should be no less beneficial to industries — at any rate, a yearly stock-taking can do no harm and might do some good.

To many the year 1929 will stand out as a period of business stagnation, losses, unemployment, general disorganization. Those who have been hardest hit see little they can call progress. On the other hand, some notable successes have been achieved through these very conditions, since only the fittest can make much headway against general stagnation. Consequently, we find on reflection that the most noteworthy recent progress has to do with means whereby costs may be reduced in manufacture of metal parts or in operation of metal making plants.

Notable advances in metals during 1930

Without accepting a meticulous limitation by the calendar, it may be said that in very recent times rapid progress has been made in the utilization of alloys in those places where corrosion-resisting properties are valuable, either economically or aesthetically. Automobile builders and architects have been anxious to use stainless steel, nickel and aluminum alloys for lasting beauty and utility, to say nothing of the less evident adaptation of high nickel and chromium steels in the food and chemical industries for durable equipment. The desirability of using light, strong alloys for moving parts, or for parts which are moved by hand, is also taking hold — it is an old story to aircraft builders, but now machine tool builders and even furniture manufacturers are appreciating it.

Important advances have also been made in the welding industry. Especially has the resistance welding process offered economies in the manufacture of pieces in quantity — pipe and automobile wheels, to mention only two instances — economies which are most attractive in times of industrial depression. Continuous and noteworthy progress has also been made in other branches of welding, such as in the construction of drums for high pressure and in building construction.

A broad view of the metal producing and consuming industries also indicates that there has been in quite recent years a decided awakening to the value of research. Important factors in the metal industry are organizing staffs for fundamental research; other corporations, older in belief, are consolidating and reorganizing their investigations for more intensive work. The success of Battelle Memorial Institute is evidence of this trend. Other phases of development in research are commented upon elsewhere in these columns, as they affect the Bureau of Standards.

Extensive studies on well-built open-hearth furnaces in operation, utilizing most modern methods of automatic control, have indicated that steel makers must revise their ideas of the upper limit of economical production. "Metallurgical control" of all phases of special and alloy steel making — once a rarity — is now becoming commonplace. Only by this means can be met the demands of the discriminating purchaser, continually more exacting and more precise.

Aside from the revolution in sheet and strip mill practice (which is a change started some years ago), and the current large readjustment in the methods of manufacturing pipe, the cold finishing mills have been under close scrutiny. Strangely enough — or is it so strange? — it has been found that the traditional speeds of cold rolling and wire drawing can be increased enormously, and at the same time the quality

of the product maintained, even increased, and certain notable collateral economies effected.

If, in this brief review of major movements, it may seem that emphasis has been placed on production economies, that fact is merely a reflection of the financial conditions existing in 1930, and of the principle that "the best is always cheapest."

Metal study slackens at bureau of standards

EXAMINATION of Dr. G. K. Burgess' annual report of the Bureau of Standards brings to light some facts which are important, and which are not evident to a visitor at the Bureau, whose critical eye is likely to be dimmed by his admiration of the institution as a whole, or of the achievements of some branch or of an individual scientist.

First is the matter of personnel. Approximately 1,100 are on the staff with average salary of $2,450. Such salaries and wages, aggregating about $2,700,000, absorb nearly all of the Bureau's $3,000,000 appropriation, the balance being spent for new equipment, testing machines, general expenses and supplies, and power plant machinery.

Despite the probability that a large proportion of the total staff is in the low salary brackets, an average wage of $200 per month does not allow very generous pay for the departmental heads or responsible investigators. This circumstance is undoubtedly reflected in a certain instability within the organization. Men trained at the Bureau are constantly shifting to other Government departments or into industrial positions. Junior members might be lost with equanimity, but all too frequently we hear of the defection of some member of the staff, long and honorably known for excellent work in an important specialty.

Business leaders have been looking upon this migration as one of the greatest services rendered to business by the Bureau. It ballasts their own modernistic organizations with solid fundamentalism. However, it should come to them as a shock to learn that last year there were no less than 645 promotions and reclassifications to higher grades and a turnover of 22.2%. On the face of these figures, 889 out of the 1,100 employees were new to their jobs! This would be a serious handicap to face even in a plant where machine tenders could be trained in a fortnight — in a research organization it means a disastrous cut in efficiency.

That this represents a fair appraisal of the situation may be proven from a glance at the brief notes on the metallurgical division. Seven projects are of sufficient importance to be described, two of which are in cooperation with research associates maintained by interested firms or associations!

It is, of course, better to confine the energy of the available workers to a few projects rather than diffuse it on a large number. Nevertheless, it needs little argument to establish the fact that a salary list of $51,000 (2% of the total) and seven investigations on metals are not commensurate with the size of the American metal industry nor the number of its unsolved fundamental problems.

No one is to blame for this but the metal industry itself. It is a truism of politics that governmental officials pay most attention to the faction which makes the most noise. Tremendous sums are constantly being spent on agricultural projects to care for real or possible needs of the farmers, vociferous through their representatives, while an equally numerous but submerged population of tenement dwellers gets only perfunctory notice. For that same reason, appropriations for metallurgical work at the Bureau will be restricted until such time as the metal industry expresses itself in no uncertain terms about the economic value of such work as can properly be done there, and continues such vigorous talk year after year.

Recently there seems to be a widespread expansion of research in industry. New institutes have been opened and have received support. Research laboratories, established some years back, are expanding their activities

even in these times of business depression when curtailment is the order of the day. Corporations, heretofore unwilling to finance anything but desultory inquiries into current machines and methods, are organizing research for a longer view ahead.

Perhaps this collective movement will spend some of its energy in the direction of the Bureau of Standards. Leaders of industry will find that in years past they have neglected to foster one of their most potent assistants. Turning that way for help, they will find a group of men anxious to serve in any way possible, but having available a smaller reservoir of fundamental facts than might be expected. They will find a skeleton organization from which few recruits can be enlisted. If this situation hurts industry badly enough so it will yell, the Bureau will be started on the road where something can be done about it.

IT IS RECORDED that the first use of iron pipe (other than cast iron) occurred in 1815, when Murdock promoted a gas-lighting plant for London. The inventor collected old musket barrels, which he screwed together to form continuous tubes reaching from his coal gas generators to the burners.

Suppose, if you can, that modern equipment for fusion welding had been available to Murdock a hundred years ago, and to the inventors who developed butt-welded and lap-welded iron pipe — not only available, but well enough known so a welded joint was the standard joint in 1887 (when the first steel pipe was made).

Suppose welding had been invented first

In other words, picture a situation where piping or plumbing contractors had acquired long experience with the oxy-acetylene cutting and welding blowpipe and had organizations well skilled in the use of these tools. Architects and designers would be familiar with the properties and capabilities of welded joints; pipe and valve manufacturers would be producing lines of goods especially designed for welded joints.

Suppose such a piping contractor in such an age had been approached by a salesman with this new idea: That pipe joints should be made by screwing together instead of welding. How far do you suppose he would get in his argument?

Here are the "advantages" which such a change would involve:

In the first place, the all-purpose tools so familiar (the cutting and welding equipment) would be superseded by hacksaws, pipe cutters, and a series of thread-cutting dies and die holders, a different die for each diameter of pipe to be used.

In the second place, the contractor would be invited to purchase and carry in stock a large number of ells, tees, branches, reducers, plugs, flanges, bolts and gaskets — a complete supply for each diameter of pipe in use, multiplied by two if light pressure and heavy pressure work were in prospect.

Third, the owner of the installation would be asked to assume the added expense of buying pipe heavier than really necessary to carry the pressure — pipe with walls thickened from end to end to give enough stock for the threading at the joints.

For a "bottle tight" joint, industry would get a mechanical fitting with many chances of leakage — a joint which, if by excellent workmanship is originally tight, is certain to be the source of eventual trouble, either through the loss of valuable contents of the pipe or by damage to surrounding property by escaping liquid.

Lastly, the prospective purchaser of the screwed joint would be asked to endure a multiplication of work, expense and time when additions or alterations to existing pipe systems were to be made.

To balance these inherent characteristics and disadvantages of the screwed pipe joint, what could be offered in compensation to an industry, a firm or a workman already possessing welding equipment and welding skill?

STEELS FOR . . .

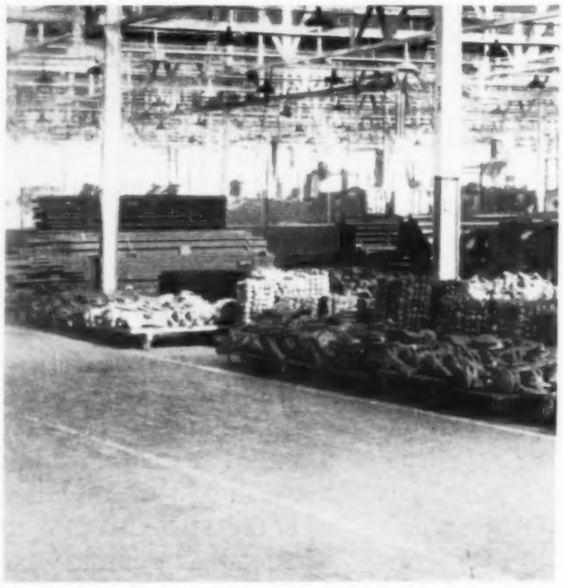
AIRCRAFT ENGINES

1918 VS. 1930

DEVELOPMENT of the gas engine has been so rapid and has so vitally affected the life of every man in civilized countries that it is frequently cited as a measure of latter day progress. For instance, in 1880, when internal combustion engines first emerged from crude experimentation, stationary units weighed about 500 lb. per hp. Within ten years this figure had been cut to 75 lb. and some idea of the future importance of these prime movers had been glimpsed. At the turn of the century, automobile engines weighing 10 lb. per hp. were available, the revolution in road transportation had commenced, and the first airplane flight by the Wright brothers was just ahead. In 1910 a little flying was being done in wooden and fabric planes driven by motors weighing about 3 lb. per hp. Today the average figure for commercial aircraft engines is about 2 lb. per hp., and for racing and special types approximately 1 lb.

Much of this has been accomplished by the substitution of aluminum alloy castings for the cast iron, and heat treated alloy steels for the commercial bars of 50 years ago. Much has also been due to researches into fuels, refinements in mechanical design, and knowledge of aerodynamics. Steel maker, steel treater, machinist, mechanical engineer, petroleum chemist and aeronautical engineer all have had their share.

If we except the introduction of the heat treated light alloy castings and forgings, which now comprise nearly half the weight of an air cooled engine, there have been no revolutionary changes in the design or construction of aircraft engines since the war. The trend has been rather toward a more smoothly running engine by improving the minute details, increasing by 40 per cent the power output per cylinder, and reducing gasoline and oil consumption. By



rigid inspection of materials and by meticulous attention to manufacturing, the aircraft engine has become one of the most efficient prime movers, and (as evidenced by a number of endurance flights) one of the most reliable.

Further evidence is available that, thanks to the care and skill of steel and alloy maker, airplane accidents due to failures of material are comparatively rare. One hundred per cent inspection at various points in fabrication eliminates most of the defectives before getting to the assembly floor. F. T. Sisco, when chief of the metallurgical laboratory, Wright Field, made the statement that 90 per cent of all recorded failures of aircraft material occur during test. Army aircraft official records also show that the large majority of accidents during flying are due to personnel failures. Colonel Lindbergh thus has ample grounds for his confidence in the safety of aerial transport.

Rapidly changing demands upon a newly discovered arm of the service made for chaotic conditions during the war, at least as far as engine construction was concerned. At the very time when every one was concentrating on essentials, no less than 175 different specifications for aircraft steels were more or less officially promulgated by the Allied Governments. Not until the fall of 1918 was it possible to codify this matter, too late to do much good. It is of interest to review the classification then agreed upon as generally used by manufacturers, and therefore including steels considered indispensable:

Carbon Steels: 1010, for case hardened parts subjected to severe friction but not fatigue, such as camshafts, wrist pins, tappets, and thrust bushings.

1020, for cylinder sheets, fuselage fittings, bolts, screws, and pins.

1030, for above category of parts of rather greater importance, and which are not to be soldered, brazed or welded.

1040, for parts requiring strengths on the order of 90,000 lb. per sq. in., subjected neither to friction or severe fatigue, such as cylinders, coupling disks, spark plug caps, spring washers, propellor hubs, turn-buckles, fork joints, and crank cases.

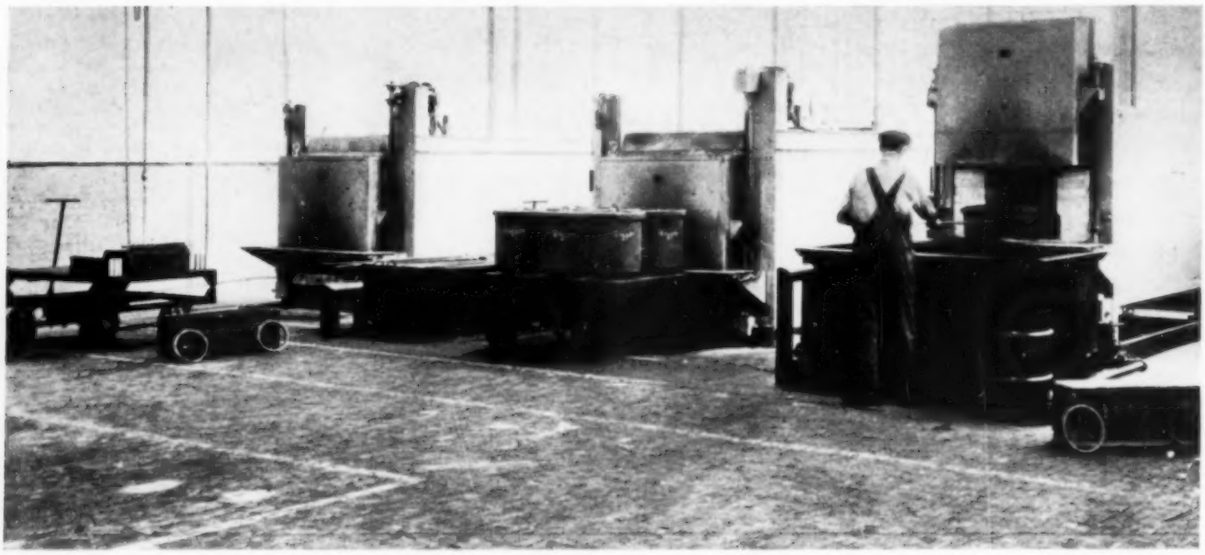
1070, hard steel for springs, streamlined wires, and piano wire (the latter is patented, cold drawn wire).

Chromium Steel: 52100, for ball-bearings, ball-bearing races, and valve-rocker rollers.

Tungsten Steel: 7650, for use in permanent magnets.

Nickel-Chromium Steels: X 3210 (Ni, 2 per cent or more; Cr, 0.5 per cent or more), for case hardened parts subjected to severe friction and severe fatigue stresses, such as cams, piston

Rough Forgings for Wasp and Hornet Engines. Bar Stocks in rear.



pins, pump spindles and some gears and pinions.

3435, for medium hard parts subjected to severe fatigue stresses, such as crank-shafts, connecting rods, pump spindles, some pinions, gears, bolts and studs.

X 3335 (Ni, 3.0 to 4.5 per cent) self hardening steel for heavily loaded parts carrying fatigue stresses and wear where low ductility is permissible, such as connecting rods, some shafts, gears and pinions.

High Speed Steel, for tools and valves.

This completes the list of "essential" aircraft steels as of 1918. Trend in what may be regarded as the best metallurgical practice in the last 12 years, can be appraised by comparing the above list with that of steels ordinarily used by Pratt & Whitney Aircraft Co., Hartford, Conn., in the construction of radial aircooled motors well known as the "Wasp" and "Hornet" types. It is true that a list made today would omit the special steels used for ball and roller bearings, magnets, valves and springs because such parts and the electrical equipment are purchased by most engine builders from other companies which have concentrated on their manufacture. As is well known, great advances have been made comparatively recently in the metals and alloys entering into such specialties.

Carbon Steels used at the Hartford factory are as follows: 1020, for unimportant parts machined from bar stock to be case hardened; tubing cut for spacers; forgings used for counterbalances attached to main shaft; small bolts and fixtures.

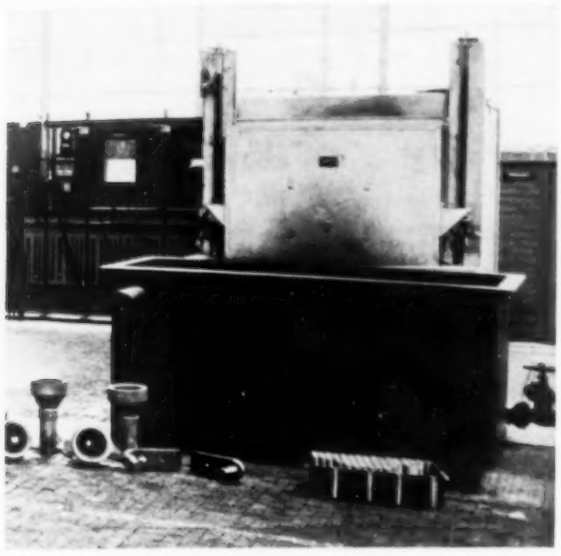
1035, for rivets for attaching counterbalance weights, studs, bolts and nuts generally.

Mild steels of the two analyses above are ordered in bar form, heat treated to one or the other of the following physical specifications: *(a)* Brinell 159 to 202; minimum elastic limit 45,000 lb. per sq. in.; minimum elongation in 2 in., 20%; and *(b)* Brinell 202 to 241; minimum elastic limit 70,000 lb. per sq. in., minimum elongation in 2 in., 18%. The upper hardness is still easily machinable, and such heat treated bar stock produces parts with a higher degree of uniformity than could easily be produced by heat treating the finished part, and at a smaller overall cost.

1050, used principally for cylinder barrels. These are purchased by Pratt & Whitney Aircraft Co. in the forged, rough machined and heat treated condition. The hardness limits are from 179 to 201 Brinell, (sometimes 228 to 241).

PWA 10115 (C, 1.10 to 1.20; Ni, 0.15 max.; Cr, 0.15 max.; Si, 0.35 max.), a carbon tool steel grade used for dowel pins, tappet roller pins, plug exhaust valve tips, and parts which can be hardened without regard to a minor amount of warpage.

Chromium Steel: PWA 51100 (C, 0.95 to 1.05; Mn, 0.20 to 0.35; Ni, 0.15 max.; Cr, 0.40 to



Carburizing Operations Require the Four Electric Furnaces Shown at the Left. Two Homo furnaces used for tempering operations are shown at bottom of page.

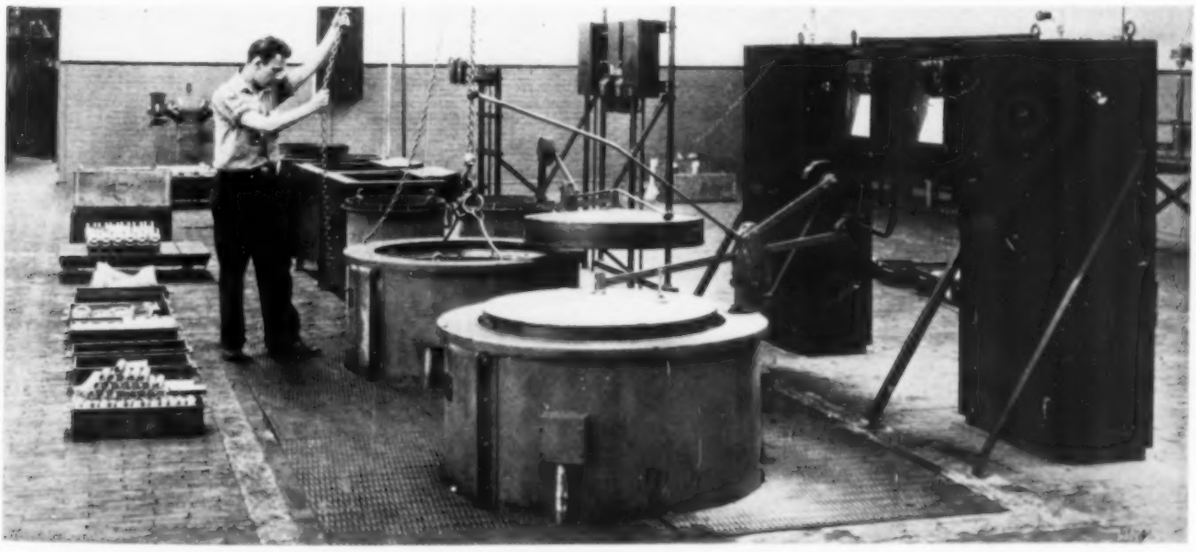
0.60; Si, 0.35 max.) may be listed here, as it forms a substitute in some instances for the plain carbon steel mentioned just above. Flat forms, washers and spacers are made of it advantageously, for it oil hardens easily and more uniformly, and with less warpage.

Nickel Steels: 2315, used mostly as tubing, and is cut into spacers.

2340, for articulated connecting rods, which are bought in the forged condition, heat treated in the forge plant to Brinell 286 to 302, minimum elastic limit 105,000; minimum elongation in 2 in., 17%; and minimum Izod impact 45. This analysis forges well and can be heat treated very uniformly. At least one rod in every 50 is cut into test pieces for strength, cleanliness, and microstructure.

2512, used for most of the case hardened gears and cam rims. The former are ordinarily purchased from gear manufacturers, made from material furnished by Pratt & Whitney. Cam rings are machined and heat treated in the Pratt & Whitney plant. A single quench from 1420° F. after carburizing gives sufficiently good structure in both case and core and minimizes distortion. A rather interesting innovation is the manufacture of crank shafts from 2512 (instead of the PWA 3142 to be later described)

	S.A.E. 2512	PWA 3142
Ultimate strength	170,000	140,000
Elastic limit (drop of beam)	165,000	125,000
Elongation in 2in.	15	19
Contraction of area	50	55
Brinell hardness	300	300



for some of the special engines. A case 0.050 to 0.060 in. thick is carburized on the bearing surfaces only. Representative tests cut from the core of the heat treated shaft are shown at the foot of the preceding column.

Nickel-Chromium Steels: 3115, for small parts such as valve tappet rollers and push rod ball ends. Also 3140, and PWA 3142 (an analysis on the high side of 3140: C, 0.35 to 0.45; Ni, 1.25 to 1.75; Cr, 0.70 to 0.90), are used for master connecting rods, and crank shafts. Every forging has a test piece forged on its end; forging and test piece are punch numbered so identification can be complete and are not separated until machining starts. A representative set of figures for the master connecting rod is:

	Actual	Specified
Ultimate strength	150,000	—
Elastic limit (drop of beam)	135,000	more than 105,000
Elongation in 2in.	19	more than 17
Contraction of area	55	—
Izod impact	55	more than 45
Brinell hardness	302	286 to 302

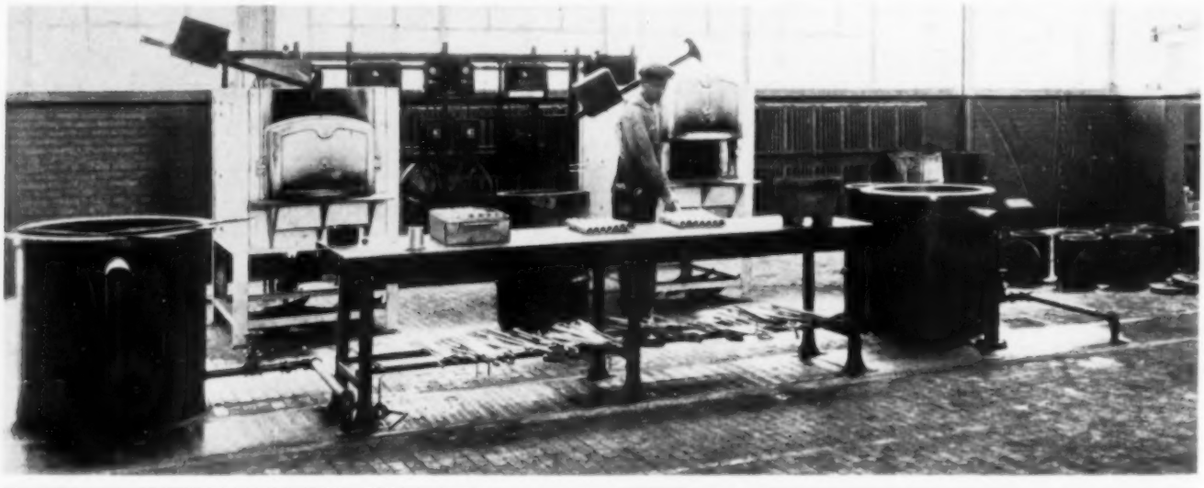
It is to be observed that the hardness is held at the top limit consistent with machinability.

Chrome-Vanadium Steel: 6150, for piston pins, gears, bolts. This important steel is bought as forgings, bars and tubing heat treated to various physical specifications. Most of the nuts, bolts and studs used in the engine are made from cold drawn stock, heat treated either before or after drawing. Minimum elastic limit (100,000 lb. per sq.in.) and minimum elongation in 2 in. (18%) are the same for both varieties, but the Brinell hardness of the cold drawn stock, 214 to 262, is raised by subsequent heat treatment to the range 262 to 302. Heat treated gears are also made of this analysis (rather than the 3250 nickel-chromium steel often favored). Minimum physicals specified of the gear makers for the completed parts are: minimum elastic limit, 170,000 lb. per sq.in.; minimum elongation in 2 in., 10%; Brinell hardness, 375 to 430.

From the comparison of the 1918 list of steels with the 1930, it is evident that the medium carbon cylinder is about the only one which is unchanged. In 1918 the principal reliance for stressed parts, such as shafts, gears and connecting rods, was upon the higher nickel-chromium steels. Sound parts of these steels were found to be difficult to make at every step through the manufacture, and modern practice favors lower or simpler alloys, which develop few defects in forging, and are machined readily after heat treating to a correct strength and toughness.

To indicate the pains which are taken to insure that no important parts are made of defective material, the manufacture of piston pins from 6150 steel may be described in some detail.

Piston pin material is cold drawn tubing. It is bought to close chemical analysis. Mill inspection is done by Government inspectors, since a good number of the engines are destined for Army or Navy service, and covers such items



as heat analysis, surface and size inspection. Every tube has heat number stamped on it and the end painted white according to the established color code. As these tubes are drawn from stock, a piece is cut from one end, and the tube and test piece given the same serial number. Each test piece is analyzed quantitatively for carbon, and qualitatively for chromium and vanadium, in order to make sure that there has been no admixture of stock, and pickled in strong acid to make sure of its structure. This tube is then machined into piston pins, each one of which is stamped with the serial number of the tube, and this quantity is kept segregated as one lot.

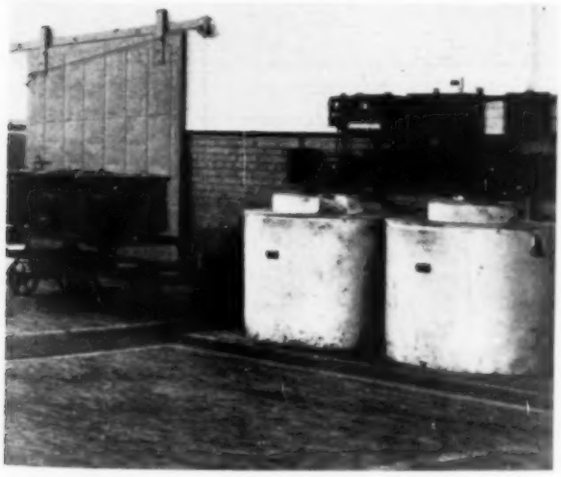
On arrival at the heat treating department a ticket is made out containing the name of the part, lot number, quantity, kind of steel, the operation necessary and the required physical property (hardness in this instance). Correct heat treating cycle is also specified, and space is available on the ticket for recording the operators' name, furnace number, record chart number and date, and all data secured by the inspector.

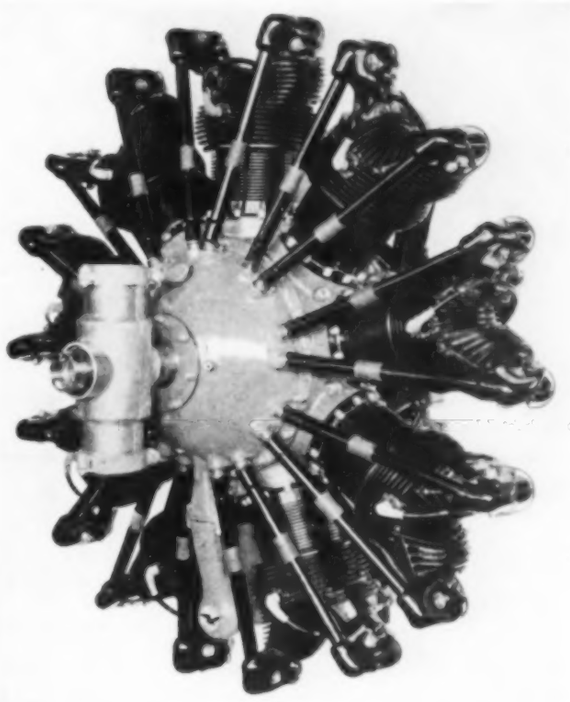
Piston pins are heated to 1620° F. in an electric furnace under automatic control, and held at heat 10 min. They are oil quenched and given a 30-min. draw at 550° in one of the Homo furnaces.

In order to give adequate inspection of the surface, the hardened part is first sand blasted to remove scale, then etched in 5% nitric acid in alcohol to develop tiny surface cracks, or other defects. After washing, the pins are inspected outside and inside under a glass, and then baked at 300° F. for 60 min. to prevent hydrogen brittleness. Finally the pins are given a 100% inspection for hardness and must measure Rockwell C 50 to 53 before passing to finish grind.

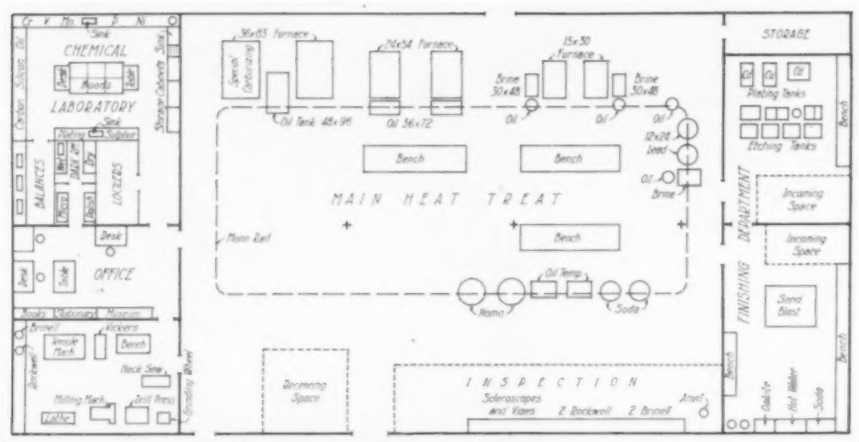
If one of the pins contains a surface defect, all the others are re-etched and re-inspected. If a second defective is discovered during this process the entire lot made from that bar is scrapped.

The department provided for these metallurgical operations and supervision (on the plan shown on page 76) is in keeping with the rest of the model factory recently completed by Pratt & Whitney Aircraft Co. in Hartford. The quarters were designed by H. J. Fischbeck, chief metallurgist, who incorporated in it ideas gathered from previous experience in laying out and operating similar departments for Wright





General Assembly of Pratt & Whitney Series C Wasp Engine, 420 Hp., at 200 Rpm. It weighs 695 lb. Engines of this series have established several world's records. Below is a corner of heat treat containing lead pots and small furnaces.



Floor Plan of Metallurgical Department at Pratt & Whitney Aircraft Co., plant at Hartford, Conn.

Aeronautical Corp., Paterson, N. J., and Wright-Martin Aircraft Corp., New Brunswick, N. J. It occupies a roomy annex to the main factory, with glazed walls and saw-tooth skylights, the latter opened and closed by remote-controlled motors. Venetian blinds are necessary to keep out excess sunlight. Floor is of special fire brick, so it is unharmed by hot steel or carburizing boxes.

All furnaces are in pairs, with individual control and pyrometer indicators at the rear wall, between the furnaces. Roller-top tables and quenching tanks are all built with tops at the same level as the furnace hearth, so the hot charge slides from one to the other easily. The large heat treating furnaces are of General Electric manufacture. No gas screen is used; the doors fit very tightly, are excellently insulated, and provided with automatic reversing mechanism which operates should they meet an obstruction when lowering. These furnaces are at heat continually (to economize electricity), and the cycle is adjusted to 24 hr. by proper mixture of spent and new carburizing compound.

In laying out the heat treat department, Mr. Fischbeck determined to consider the reliability of the equipment to produce the best uniform results and to make this equipment flexible so as to heat treat a large variety of parts. Only equipment of standard make was considered, and no equipment was specially designed. After considering the advantages and disadvantages of the different types of fuel (gas, oil and electricity) electric heat was decided upon for the following reasons:

1. High efficiency, together with quality of work produced,
2. Simplicity of application,
3. Close automatic control of temperature,
4. Cleanliness and improvement of working conditions, as the heat treating room is free from fumes and smoke,
5. Impossibility of overheating any part of charge, because temperature of source is only slightly above temperature of charge,
6. Elimination of combustion, with the attendant uncertainty of results and general fuel problems, together with reduced fire hazards.

By J. C. Weaver

LAYOUT FOR . . .

BATCH PICKLING

OF THE THREE general methods of pickling, the one to be discussed in this brief article operates on batches of material. It requires a group of tanks in which the pieces are submerged in the various solutions until action has been completed. In another method, the metal pieces are hung on hooks on an appropriate conveyor and run through a succession of tanks; the work is continuous and is completed without manual handling en route. The third general process applies mechanical agitation to regular batch pickling. The first mentioned method of pickling is the more common of the three, since the production of so many plants either lacks the quantity required for specialized production equipment, or the sizes and shapes are not adapted to simple holding fixtures other than baskets.

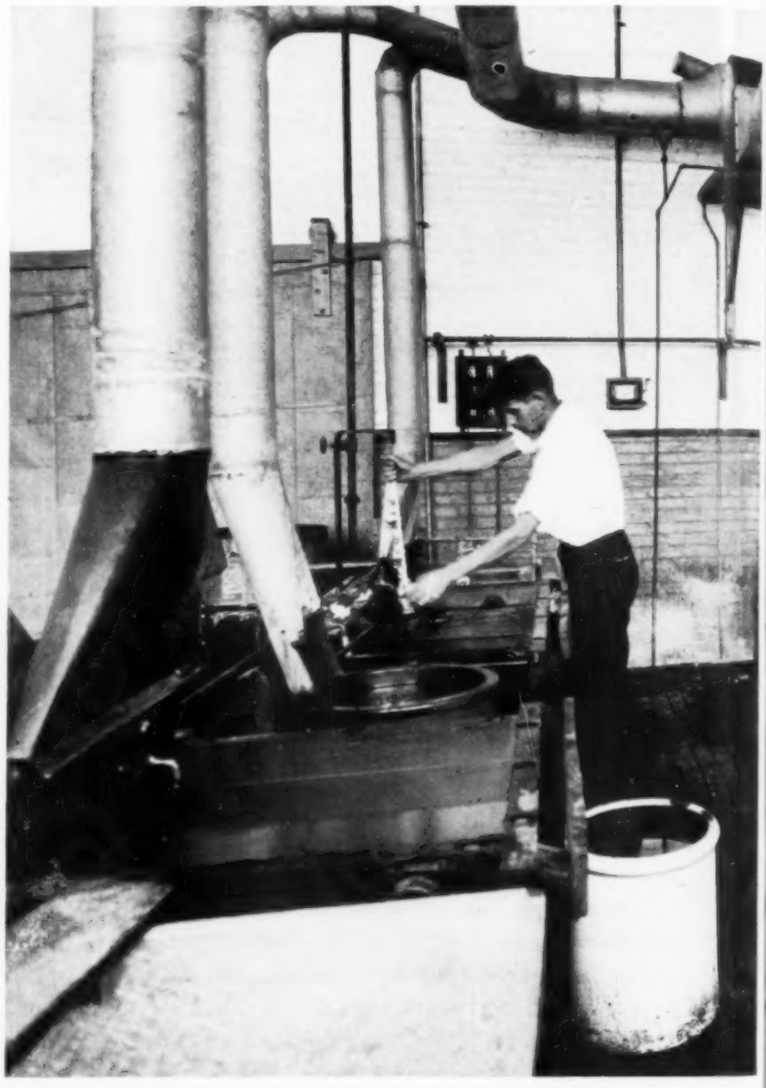
With the various solution controls now available, it is perfectly safe to build a pickle room into the regular production line, thus eliminating the long haul to separate buildings and the required extra handling. Assuming that the manufacturer will properly control these solutions, the next item to consider is the space required for the job to be done. Pickling departments can be adapted to almost any area or layout; they can be built as a long, straight, narrow series of tanks, in circular or U shape procession, or the tanks can be so placed that a rectangular or square floor plan can be used. Therefore, it is rather difficult to generalize. It is better to consider one of two specific installations.

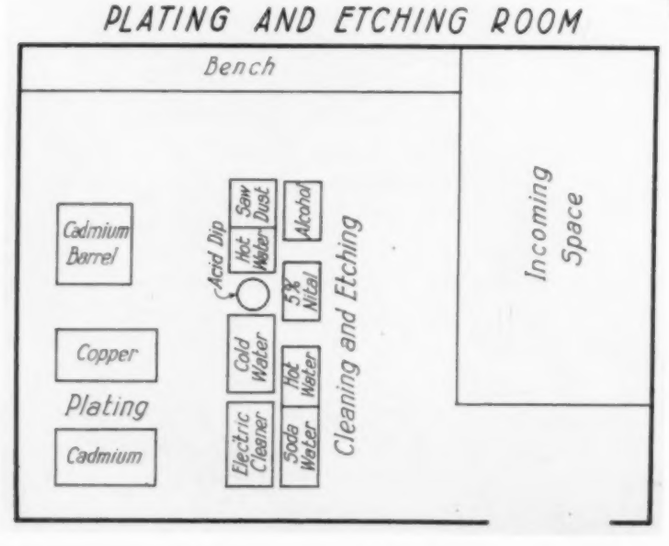
As an instance of an excellent layout for an intermittent and relatively small production of light parts, the floor plan and an interior view of Pratt & Whitney Aircraft Co. cleaning and plating room is shown on the next two pages. Material handling is no great problem. Proper ventilation, however, is essential, and the exhausts shown are very efficient, being much better than hoods formerly used. The floor of the room is graded, and through the center is a 12x12-in. trough leading to a sewer—all this, of course, is underneath the floor boards. Worthy of note is the guard placed in front of the cleaning tanks to prevent the operator from coming in contact with the edge, and thus he can keep himself dry.

A much more difficult problem for analysis is as follows: Assume that we must clean tractor and automobile parts, and that it will be necessary to pickle 100,000 lb. of forgings per day. Included in this production will be crank shafts, axles, connecting rods, various types of braces

and other small miscellaneous pieces. The longest pieces will be 40 in., while the smallest will be ½ in. diameter. In a plant producing such a miscellaneous assortment of pieces, it is well to provide two types of baskets, one made of bar and angle iron (as shown on page 80) to handle the heavier and larger pieces, while the other would be made of perforated plate. The number required and the size will be determined later.

A production of 100,000 lb. in a 9-hr. day would mean that approximately 12,000 lb. must go through the department every hour. By experiment it has been determined that the maximum time for pickling forgings of this type is 20 min. This means that the workmen will make up three batches per hour — approximately 1,000 lb. on a 20-min. cycle. Inasmuch as it is generally advisable to limit the load to 1,500 lb. of forgings in one basket, it will be necessary to have three basketloads pickling at one time. In this particular plant, let us make the reasonable assumption that there will be more heavy forgings coming through than small ones. Therefore, five baskets should be provided for heavy forgings while three for the lighter variety will be sufficient.





Inasmuch as the longest piece is 40 in., baskets should be at least 45 in. long inside, 36 in. wide and 24 in. deep. This will be sufficient to carry the required 1,500 lb.

If the acid tanks are built 8 ft. long by 6 ft. wide by 42 in. deep, two loads can be accommodated in each tank, with the baskets set crosswise. Due to the fact that sometimes it is necessary to have two different concentrations or even acids for pickling

An Interior View and Floor Plan of an Excellently Arranged Cleaning, Plating and Etching Room for Diverse Production of Small Parts. Courtesy Pratt & Whitney Aircraft Company.

certain kinds of forgings, two acid tanks should be installed, even though they would permit a 33⅓ over-production. A further advantage is that the department can continue even though there is trouble with one of the acids, or when production is falling off, one of the tanks can be drained. An excess tankage capacity is not always advisable, but in this example it would be considered good practice.

The tank layout is completed by adding a rinse and a neutralizer tank. It is sometimes advisable to include a tank for oiling the cleaned work, when it is necessary to ship forgings immediately after pickling, and they must arrive clean and bright without rust.

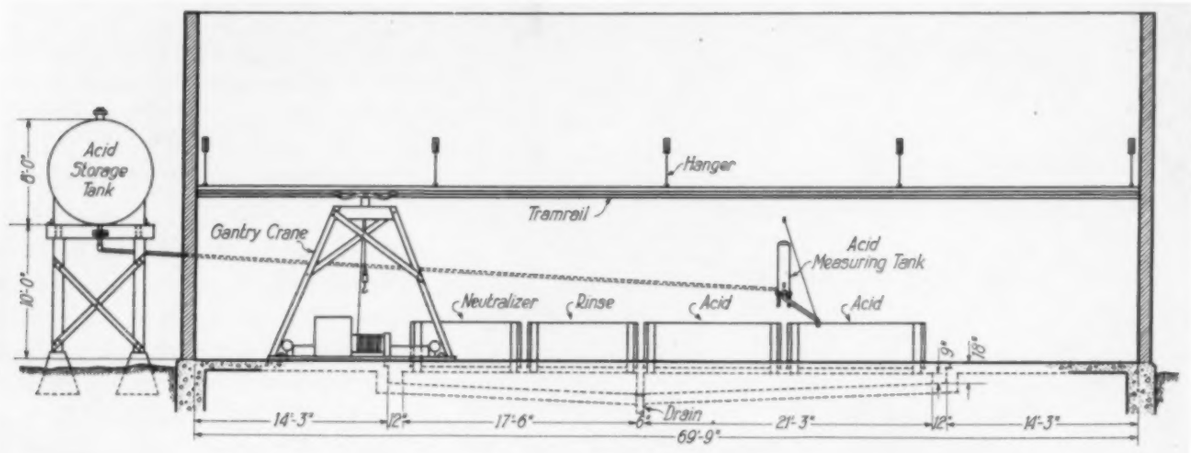
To make this plant a modern one, it is necessary to install handling equipment. For a straight line as shown, a gantry-type crane is quite desirable. One man can put all the work in and out of the tanks, and deliver it ready for the next production operation. All this is shown on the plan, page 80.

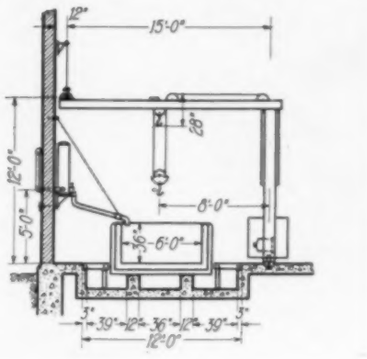
The tanks should rest on concrete joists, elevated above a drainage pit, properly sloped to take care of drainage. The pit is made about 24 in. wider and longer than the outside dimensions of the tank layout, and this space is covered by duck boards firmly set at floor level so that any spillings will run through them and into the drain below.

Inasmuch as acid is considerably cheaper when purchased in carload lots, it is advisable where production is as large as the one just outlined, to install a storage tank. This should be placed outside the building near a railroad siding and at an elevation to drain by gravity into an auxiliary tank, placed over the pickling tanks.

This auxiliary tank should be equipped with two glass gages, graduated so that the correct amount of acid may be drawn out to increase the acidity of the solution by one per cent. Suitable piping, leading acid from storage through auxiliary tank into the pickling solution, is advisable in order to eliminate the danger in handling acid in pails or pitchers, as is the old-time method. The discharge pipe can lead from a swivel joint so it may be used to fill either vat.

Solution tanks should be heated by live steam, as this method has been found to give satisfaction, as well as being least expensive to





Outline Drawing of Pickling Room in Factory Making Automotive Parts With a Daily Capacity of 50 Tons of Forgings of Miscellaneous Size.

install. Injection of live steam also agitates the pickling solution, thereby speeding the operation. Steam jets can be placed in the corner of such small tanks as these. In longer tanks, it is often better to arrange for a jet in each corner and even occasionally on the sides to increase circulation of liquid and distribution of heat.

The tanks would, of course, be equipped with temperature controls to keep an even temperature at all times in the pickling baths, and these may be mounted on a wall adjacent to the tanks.

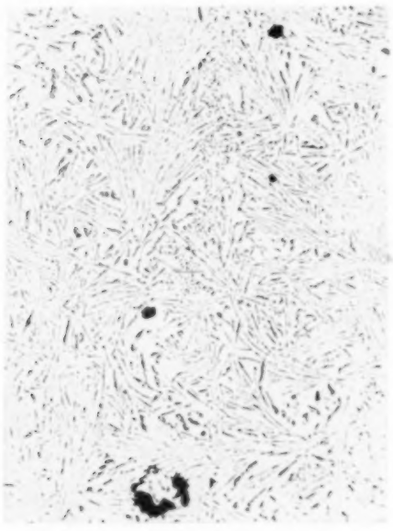
As a justification for this straight-line batch pickler, equipped with gantry crane, it may be said that the cost of operation will be on the order of $1.25 per ton of forgings pickled. In a plant not well supplied with solution controls or efficient mechanical handling equipment, it is not unusual to find the costs mounting to $3 per ton. When the savings effected by modern installations are considered, it is very easy to see that a reasonable sum of money can well be spent to put in the proper devices.

There is, of course, an infinite number of variations that can apply to this same general problem, and could only be decided by a consideration of the actual plant conditions. For instance, when production is not so high, an ordinary electric or air hoist may be suitable. The extra acid tank may also sometimes be eliminated, but the writer believes that the general solution indicated above is most satisfactory for a production plant and low costs.

Basket For Pickling Axles and Heavy Parts Is Made of Stout Angle Iron and Bars. Smaller pieces, down to 0.5 in diameter, should be handled in baskets made of perforated plate.

Modified Aluminum-Silicon Alloys

All of ½-In. Test Bars, as Cast in Green Sand. Relatively pure metal was used in order to simplify the microstructure.

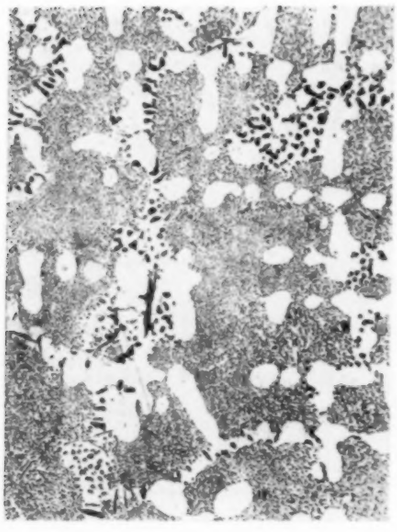


Structure as Cast

Silicon 13.2%; iron 0.3%; copper 0.04%

This is the non-modified structure included for reference. It consists largely of normal Al-Si eutectic, the silicon existing as plates or needles. The alloy is slightly hyper-eutectic; note dark particles of primary silicon. Magnified 75 times. Etched in aqueous solution of 0.5% HF.

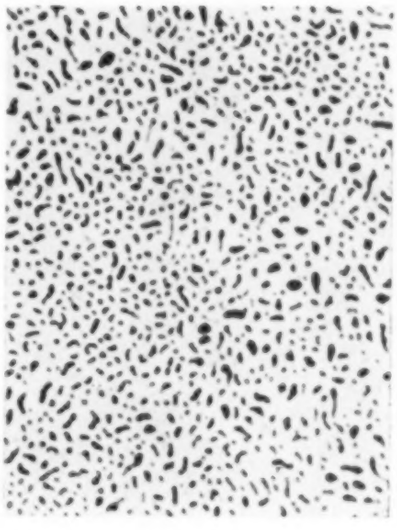
The same alloy modified with sodium before casting has this structure (same magnification and etching). Crystallization of primary silicon has been supprssed and the alloy is now essentially hypo-eutectic with white dendrites of primary aluminum. The speckled matrix is the modified eutectic, and, as shown by the lower view (unetched and at 1,000 diameters), consists of dark silicon particles in a light aluminum ground mass.

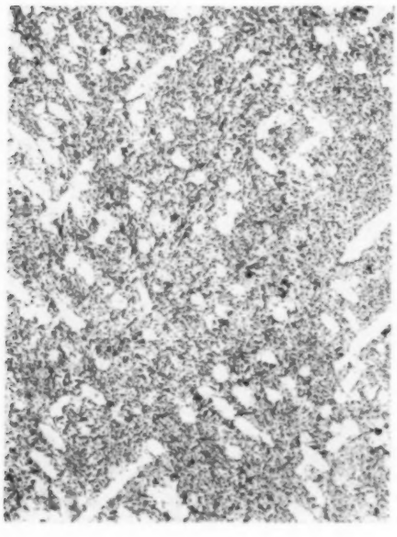


Over-Modified Alloy

Silicon 13%; iron 0.7%

If too much sodium is in the alloy at pouring, this structure may be found. Tensile properties are then inferior to those of a properly modified alloy. Occasional particles of ternary Al-Si-Fe constituent are seen in halftone. Etched in aqueous solution of 0.5% HF. Magnified 100 times.

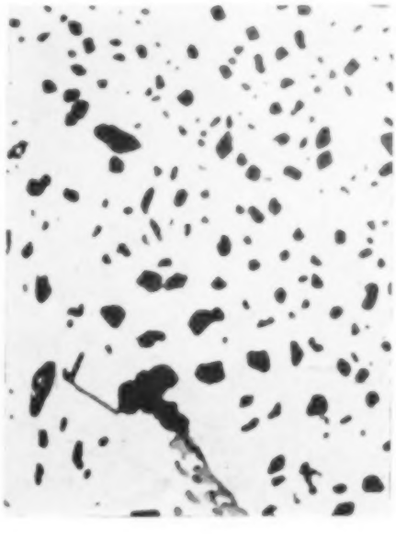




Alloy Modified and Heat Treated

Silicon 12.86%; iron 0.51%; copper 0.18%

The structure after modification can be changed by heat treatment. This sample was heated 6½ hr. at 547° C. (1,020° F.) and cooled in the furnace. Magnified 75 times. Etched in aqueous solution of 10% HF and 10% HNO_3.



Heat treatment has caused the silicon particles to grow markedly, as shown in this unetched view of the heat treated modified eutectic, magnified 1,000 times. A particle of the ternary Al-Si-Fe constituent known as β(Fe-Si) is shown near the edge.

Photomicrographs by Aluminum Research Laboratories, Cleveland.

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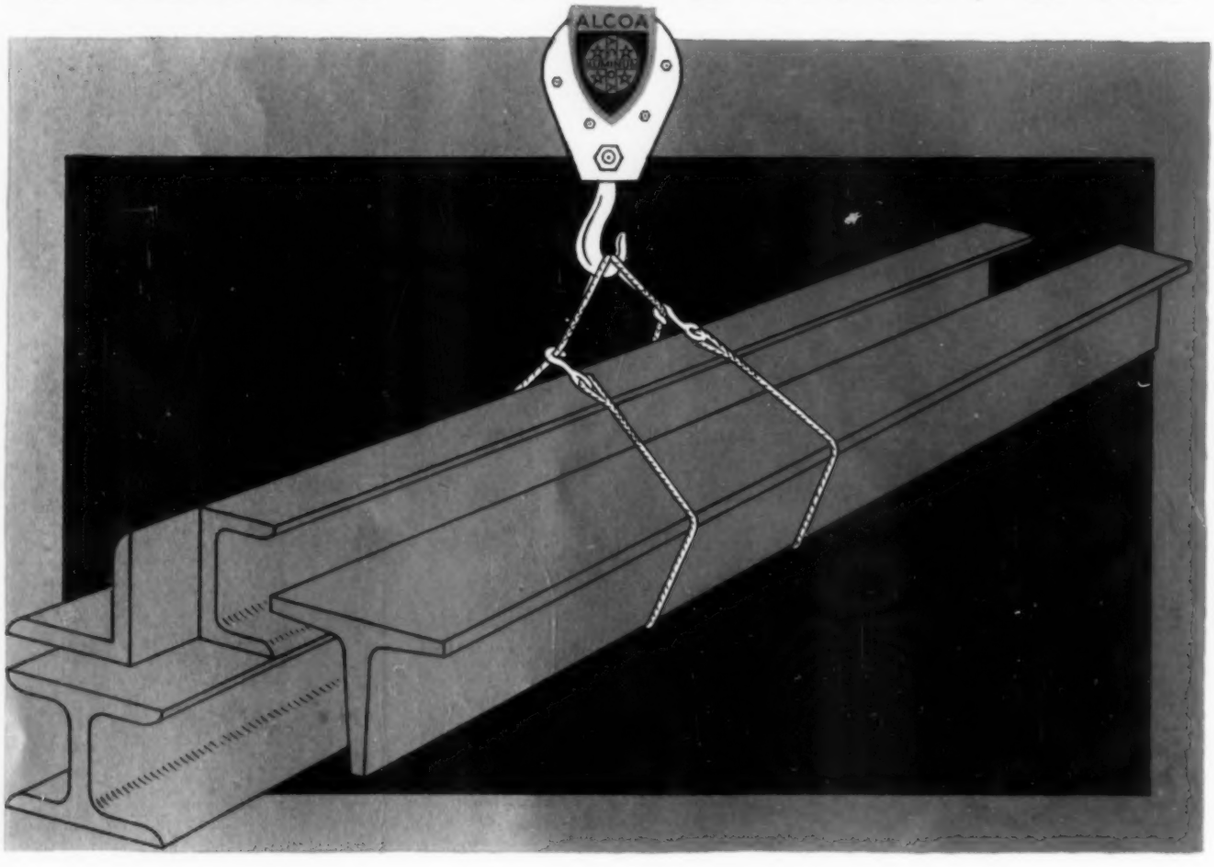
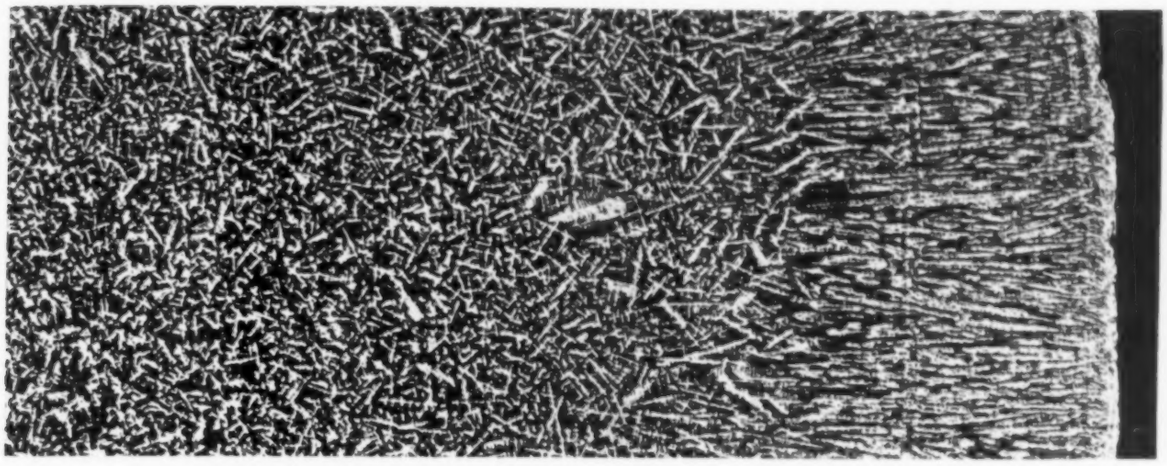
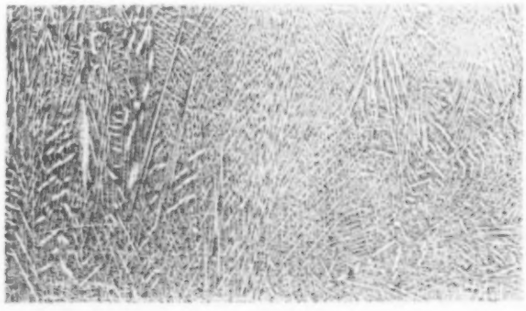


Dendritic Structure In Steel



Structure, natural size, of a 24-in. round ingot of steel for seamless tubing. Ingot cut off square, smoothed, and etched. Composition: Carbon 0.44, manganese 0.75, silicon 0.15, phosphorus 0.04, sulphur 0.04.

Plain carbon steel; annealed 2 hr. at 1,575° F. Magnified 2 times. Etched with LeChatelier's reagent. Composition: Carbon 0.50%, manganese 0.35%, silicon 0.20%.



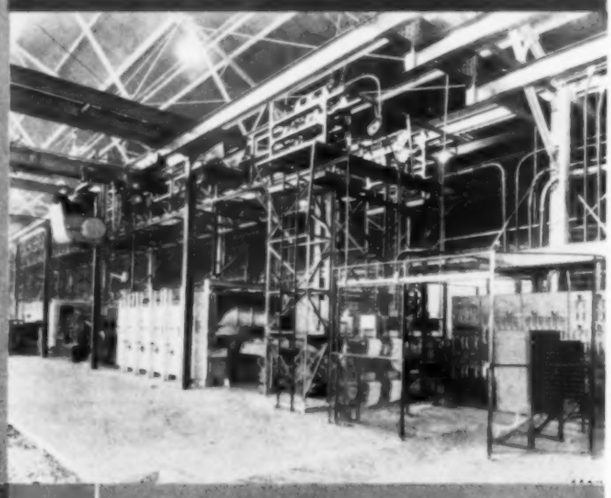
Chromium steel, as cast. Magnified 4 times. Etched with LeChatelier's reagent. Composition: Chromium 5.25%, carbon 0.70%, silicon 0.62%.

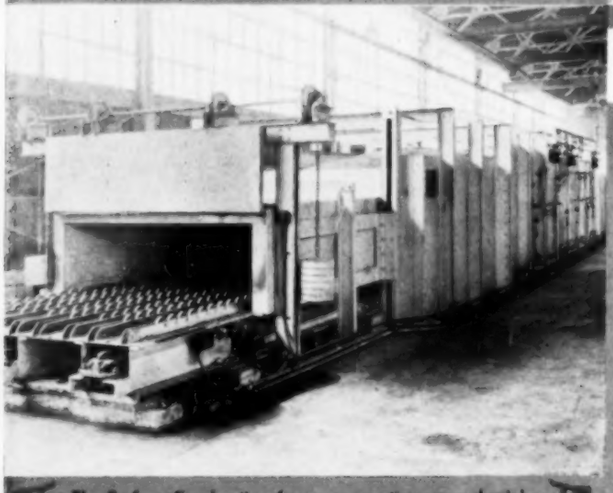
Hadfield manganese steel, as cast. Magnified 50 times. Etched with iodine. Composition: Manganese 13.5%, carbon 1.3%.

Nickel austenitic steel, as cast. Magnified 40 times. Etched with nital. Composition: Nickel about 28%.

Original photographs loaned by Vsevolod N. Krivobok, Bureau of Metallurgical Research, Carnegie Institute of Technology, Pittsburgh.

MODERN FURNACES... FOR MODEL PLANTS





The Surface Combustion four row, continuous carburizing and annealing furnace at the Spicer plant. Work is pushed through in opposite directions, and a combination preheat and cooling chamber is added at each end. Flue gases are utilized to preheat incoming cold work. (Above Right) General view of their modern heat treating and forging division.

The heat treating and forging division of The Spicer Manufacturing Company's new plant at Toledo, Ohio, is a noteworthy example of the modern trend in heat treating departments. A high degree of economy and efficiency has been reached. Universal joint parts, axle and transmission gears, and miscellaneous automotive accessories are produced for leading automobile manufacturers in the Spicer plant. All carburizing, drawing, annealing, hardening, and periodic furnaces were designed and built by Surface Combustion, including pot hardening furnaces and miscellaneous heating equipment. All furnaces are gas-fired, automatically controlled. Surface Combustion engineers will cooperate with you in solving your furnace problems.

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CORRESPONDENCE . .

. . AND FOREIGN LETTERS

Important ore discovery in North Sweden

PARACELSUS, the famous Swiss physician of the 16th century, once made a journey through the northern parts of Sweden, and in the account of his travels he ventured the prophecy that mineral deposits would be found in this country between the latitudes of 63 and 65° of such immense richness that they would far outshine the treasures of the Orient.

This prediction was whimsically revived by O. Falkman when addressing the Academy of Technical Sciences in Stockholm on the sensational discoveries of gold-bearing copper ore made at Boliden a few years ago. This place is, in fact, situated within three degrees of the Arctic circle, so that the surmise of Paracelsus has so far turned out to be correct. Even though the value of the deposits discovered is not, of course, so fabulous as the famous iatro-chemist prophesied, they will certainly be of considerable influence on the world's total output of gold and copper.

The ore deposit was not discovered by chance, but resulted from systematic and persistent electric prospecting, sometimes known as geophysical surveying. In the course of many years' work several ore bodies of less importance have been found in the region. Six years ago a very rich deposit was mapped out, having an area of about 3 acres, its greatest length about a third of a mile, and 130 ft. broad at its widest. The mineral bodies consist of copper sulphide and arseno-sulphide in lenses of varying size.

Exploratory work indicates that the average of the ore body will contain 2.3% copper, 30% sulphur and 10% arsenic. Silver is expected to average about 2 oz. and gold 0.5 oz. per ton, although in some rich ore which has been exported the gold content has been as high as 2 oz. per ton, but this greatly exceeds the average.

Next year about 300,000 tons of ore will be mined, and in the near future production is planned to reach 500,000 tons. At a village at tidewater, on the Gulf of Bothnia not far from Boliden, a copper smelter has been built which will produce next year about 15,000,000 lb. of copper, 750,000 oz. of silver and 190,000 oz. (troy) of gold.

Copper ores containing large amounts of silver are being worked, notably in Peru, but ore bodies containing so much gold and silver simultaneously are rare. The deposits must also be considered to be unique in the high arsenic content. None of the metallurgical processes used elsewhere can, therefore, be said to apply ideally to the Boliden deposit, since it is essential in the smelting to recover the maximum amount of gold, and also to prevent the escape of any poisonous arsenic compound into the atmosphere.

Ore will be roasted, as a first step. The arsenic oxide fume from this and other smelting processes is cooled and condensed in large dust chambers, and stored against an increased demand. The roasted ore will be melted in reverberatory furnaces, and the copper sulphide matte used to collect the precious metals, from which it will be recovered by somewhat conventional refining methods.

The arsenic by-product is one causing some worry. American ores, notably those in Montana, carry arsenic in comparatively minor

amounts, yet it is said that the oxide accumulates in the dust chambers more rapidly than it can be removed and marketed. Refining of flue dust to a pure arsenic oxide is fairly simple, but the only important uses at present are for insecticides and for making certain kinds of glass.

A. WESTGREN

Stockholm, Sweden.

Germans study induction furnaces

HIGH FREQUENCY furnaces (or coreless induction furnaces) are now of much interest to German metallurgists, since results already obtained in research and production work are very promising. Our first important publication was in *Mitteilungen* of the Kaiser Wilhelm Institut für Eisenforschung, Vol. 8 and 9, which described work done at that center in 1925 to 1927. These investigations were directed toward the development of rugged furnaces, and of thoroughly reliable electrical equipment. It may be said that difficulties in both these respects have been surmounted. Work at present is, therefore, directed toward the possibility of substituting high frequency furnaces for crucible furnaces and also to discover melting methods that refine the charge (as can now be done in arc furnaces). Work on the latter phase is being done in collaboration with some large steel mills, and a report can be expected from the Institut in the near future.

Very interesting experiments at the steel plant of Gebrüder Dörrenberg were described in the recent publication No. 183, Verein Deutscher Eisenhüttenleute. The results show that both in regard to quality and cost of production, high frequency furnaces compare favorably with gas-fired crucible furnaces.

Latest furnace designs are characterized by the use of lower frequency; 2,000, 500 and even 50 hertz (cycles per second) being used for electric power circuits. The old type of equipment with frequency up to 100,000 hertz is no longer in use in Germany, except in small experimental units.

German equipment is manufactured either by the Hirsch Kupfer & Messingwerke (which firm also has two furnaces of the Ajax-Northrup type in operation melting nickel alloys) or by Lorenz & Siemens & Halske. The latter firm favors motor-generator sets for the electrical installation, but both firms can deliver units from a few kilograms capacity up to about one ton. Furnaces are equipped with either water- or air-cooled coils, but the former are usually considered as more reliable, as with this design, the coils help to keep the lining in place. Typical sizes and performances of German installations may be quoted as follows:

A 650-lb. furnace is 2 ft. deep and 13 in. diameter, while a half-ton crucible has a diameter of about 18 in. Some firms have abandoned the round form, although preferable from an electrical standpoint, in order to obtain a longer life of the lining.

The usual capacity of two generators for a half-ton furnace is about 330 kva. When melting high speed steel, the current consumption is 600 to 900 kw-hr. per ton of cold scrap. Electrical efficiency varies somewhat with the form of the crucible, but is usually from 50 to 60%.

The time required to melt one charge in a 650-ton furnace is 70 to 100 min., and in a 1-ton furnace, 1½ to 3 hr., depending in each instance on how much refining is attempted. It is usually possible to pour a heat about 10 min. after melting down, but sometimes 20 min. or more is allowed for refining purposes. Usually 8 to 12 heats are produced in 24 hr., or 40 to 80 heats per week. This also approximately corresponds to the life of lining, which, however, also depends on whether it is acid or basic. With a tamped-in acid lining, the number of heats between

relining is usually 60 to 90; on the other hand only 30 to 50 heats are ordinarily obtained with a basic lining.

At present these furnaces are mainly used for remelting high grade scrap under a thick layer of slag. The temperature of the slag is comparatively low, on account of radiation; nevertheless, an active slag is often desired. How to produce such a slag is the subject of many investigations.

One big practical advantage which an induction furnace has over a fuel-fired crucible furnace is that it is easier to put double carbides in solution. This is partly due to the ease with which any desired temperature can be obtained, and partly to the swirling movements in the bath. The usual working temperature is between 1,600 and 1,700° C. (2,900 to 3,100° F.), depending on the type of steel produced. Immediately before pouring, the steel is deoxidized by adding silicon and aluminum, or a Si-Al-Mn alloy.

The quality of the steels produced is considered superior to the usual crucible steels. They are mainly high speed steels, non-rusting steels and heat-resisting alloys, and electrical or magnetic steels with a high content of alloying elements. The main advantage is said to be that steel of a high quality in any desired analysis can be produced in small quantities in a very short time. Uniform analysis, heat to heat, avoids the sharp variations that seem unavoidable in high alloy crucible steels.

It is also believed that cost of production (with the prevailing prices for fuel and electrical current in most German industrial centers) is cheaper in high frequency furnaces than in the old type of gas-fired crucible furnaces. The former are also more economical than arc furnaces of the same size — a 500-kg. Heroult furnace requires 1,000 to 1,200 kw-hr. per ton, instead of the 600 to 900 kw-hr. per ton quoted above.

The reason why the use of high frequency furnaces has not increased faster in Germany is the high cost of installation. For a 300-kg. furnace, the first cost is about M 80,000 and for bigger units, the costs are correspondingly higher.

Even so, there are at present in the Rhein-Ruhr district alone about 10 furnaces operating with capacities ranging from 600 lb. to a ton. The biggest steel ingot so far cast weighed 3,100 lb.

Besides these commercial furnaces, there are at least 50 in operation for research work. Almost every technical school where metallurgy is taught has one; most steel plant research laboratories also. The future possibilities are being intensively studied from a theoretical and practical standpoint, and the results are likely to be of great interest and importance.

E. W. Ehn

Cannstatt, Germany.

Equipment to draw heating or quenching curves

ASSISTANT Professor Seikichi Satô has recently constructed a self-recording dilatometer, which is very convenient for studying rapid temperature changes, as in the operation of quenching.

A halftone on page 88 shows the apparatus. The main horizontal member is a T-shaped hollow frame made of quartz tubing having a very thin wall. It is firmly fastened to the base plate *F*. A guide *G* is made of refractory alloy and is also fixed to *F*. A rod *R* is made of a material which has a uniform rate of thermal expansion, and a specific heat and a density approaching that of the test specimen *S*. It can be seen that the thermal expansion of *R* may be utilized for indicating the temperature of *S*.

These two rods are supported in position by silica tubes passing through the guide *G*, and they are uniformly heated together in the electric tube furnace. The same silica tubes transmit the thermal expansion of each rod to levers *L* and *P* respectively. These levers magnify the movements of the silica tubes and also transmit the respective motion to a common

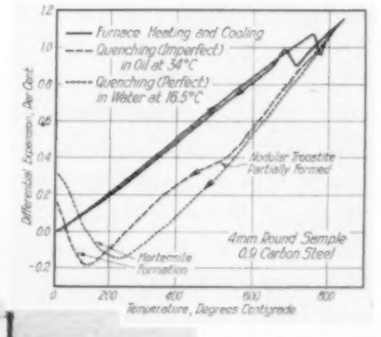
point of a pantograph at the right of the view shown below.

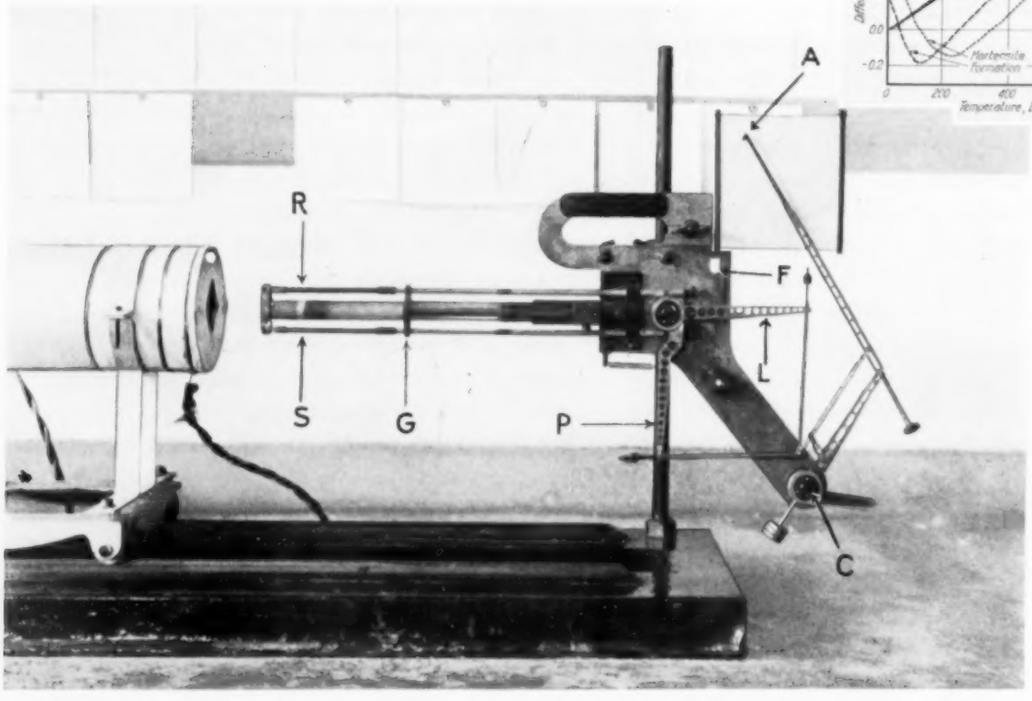
All levers are made of duralumin, lightened as much as possible, equipped with adjusting screws and arranged to swing separately round a common fulcrum *C* by means of ball bearings. Light tension springs secure a good contact between fixed and moving parts. The pantograph is also made of duralumin, finished as light as possible and perfectly balanced in order to avoid any dislocation of the pen *A*, when the apparatus is turned over to quench the hot specimen. Precise machine work is necessary to avoid lost motion, which would be fatal to the operation of the equipment.

The pen traces the motion of the common point in the pantograph in a similar and magnified curve. Thus the thermal expansion and contraction of the rods *R* and *S* are magnified 70 times, and the resultant of these movements is traced on the piece of paper under rectangular coordinates.

A handle-grip and a knob are provided so the entire equipment can be promptly moved to the quenching tank. The overall length of the apparatus is about 50 cm. (20 in., more or less) and it weighs only 700 grams, or approximately 1½ lb.

During heating, the apparatus is always clamped in a horizontal position by inserting a pair of pins through the base plate into corresponding recesses on a stand, and the heating curve is traced on the paper. If the cooling be made slowly, an ordinary cooling curve is obtained, as shown on the adjoining curve sheet in full line. If the heating furnace be removed to the left along the rails, an air-cooling curve is obtained. If a quenching is to be studied, the furnace is quickly removed at the correct temperature, the apparatus is promptly carried


Furnace Heating and Cooling
Quenching (Imperfect) in Oil at 34°C
Quenching (Perfect) in Water at 16.5°C
Nodular Troostite Partially Formed
4mm Round Sample 0.9 Carbon Steel
Martensite Formation
Differential Expansion, Per Cent
Temperature, Degrees Centigrade



Expansion of R, Transmitted to Pen A by Lever Arm L, Measures Temperature of Furnace, Whereas Expansion of S, Made of Metal Under Study, Is Transmitted to Pen by Lever P. Thus a heating or cooling curve of sample S is drawn automatically.

by hand to a nearby quenching tank and the heated specimens are plunged vertically downwards into the cooling medium.

Reproductions of the curves shown on the opposite page are from records obtained during oil and water quenching, respectively, of a high grade eutectoid steel.

KOTARO HONDA

Sendai, Japan.

IN THE October number of METAL PROGRESS there appears an article by Robert Sergeson, entitled "Progress in Nitriding".

In the introductory part of this article Mr. Sergeson states, somewhat paradoxically, that "previous to Dr. Fry's work, but little was known regarding the behavior of nitrogen toward iron; nevertheless earlier work must have been very helpful." Therefore, a brief account of it will not be amiss.

Early work on iron-nitrogen equilibrium

In Mr. Sergeson's subsequent account, it seems to the writer, there exist serious omissions. Thus, while Dr. Fry is represented as having studied the effects of combining nitrogen with different metallic elements, and with having fixed upon aluminum as having such great affinity for it that no decomposition takes place up to 1,800° F., no mention is made of the like work published in the *Journal* of the Iron & Steel Institute in 1915 by Tschischewski, who had already found aluminum to have the greatest affinity for nitrogen. An important statement by the latter is as follows: "These experiments prove that aluminum added to molten steel combines with nitrogen and forms with it a hard solution of aluminum nitride without evolving any nitrogen." As early then as 1915, Tschischewski had therefore pointed out the formation of a hard solution when aluminum and nitrogen were combined in iron.

Again referring to the earlier work, Mr. Sergeson states that such fragmentary knowledge must have led Dr. Fry to study the iron-nitrogen system first. But though Mr. Sergeson designates as "unsuccessful efforts" the fixing of the limits to which nitrogen enters liquid iron under pressure by Andrews in 1912, and the present writer in 1923, he makes no mention of the iron-nitrogen equilibrium diagram contained in this 1923 publication of the writer's (also made available to the public in 1921, as a thesis written at the Massachusetts Institute of Technology).

This equilibrium diagram, derived from thermal analysis of nitrided iron, is mentioned in Dr. Fry's 1923 publication in the *Kruppsche Monatshefte*, but is there dismissed by him as being based on heat effects of decomposition rather than those of real transitions. It is, therefore, gratifying to have had such thermal effects largely confirmed by the U. S. Bureau of Standards in the paper by Samuel Epstein, published in 1929 by the American Society for Steel Treating.

I believe that these works above pointed out should be recognized in any historical account of nitriding.

C. B. SAWYER

Cleveland, Ohio.

The above letter from Mr. Sawyer, of the Brush Laboratories Co., was sent to Mr. Sergeson, and he comments as follows:

"When any new discovery is commercialized there emerge from the background many academic endeavors which were confined to the technical literature. Thus it is with Mr. Sawyer's equilibrium diagram published in 1921, of which Dr. Fry has made mention.

"Tschischewski's paper published in 1915 under title of 'The Influence of Nitrogen on Iron and Steel' begins with the following introduction: 'The injurious influence of nitrogen on the mechanical properties of iron is now firmly proved.' It was the *detrimental* effects of nitrogen which were presented by Tschischewski with no suggestion of the useful commercial applications so definitely developed by Dr. Fry."

IRON ORE deposits worked by Cogne, the Italian metallurgical corporation described in previous letters, form an excellent basis for the sound development of an industrial program producing fairly large quantities of special steels and irons.

These deposits consist of large dykes of magnetite, equal in purity to the best among the famous Swedish magnetite iron ores. One dyke worked at present contains several score million tons of ore. The gangue of this ore is dolomitic, giving a blast furnace slag containing over 30% magnesia, and it is known that the old practice, perfected in Sweden for manufacturing high quality irons and steels, shows that the best products are obtained from magnetites containing high percentages of magnesia. The excellent results obtained during the last four years in the Aosta works in Italy, fully confirm that finding.

Duplexing in converters and arc furnaces

Our ore comes from the mine practically free from sulphur, phosphorus, copper and arsenic. It is divided in two classes. The first contains more than 54% iron, and forms about four-tenths of the total; it is charged directly into the blast furnace. The second — containing between 42% and 54% iron — is concentrated, sintered, and mixed with the first class ore in the burden. The furnace charge thus contains an average of 62% iron. The great porosity of the sinter (made by the Cockerill process) loosens the whole charge so it can be readily penetrated by the reducing gases in the circulating blast, and has a very beneficial effect on the regularity of the reactions taking place in the blast furnaces.

For a period of about six months after the works were started coke was used as a reduction agent in the electric blast furnaces, in order to study the behavior of the ore under well-known conditions. For the production of a pig iron of the desired composition (which will be quoted further on), the coke consumption during this first experimental period was about 850 kg. per metric ton of pig iron produced (19,00 lb. coke per long ton iron).

Coke was then gradually replaced with increasing proportions of anthracite from the mines of La Thuile. As the washing plants — which will lower the ash content of the anthracite below 10% — were not yet in operation, the anthracite used in this second developmental period had an ash content twice as high, which limited the proportion used in the blast furnaces to about half of the required coke. Results were extremely satisfactory; this being partly due to the fact that the anthracite ash contains a high percentage of silica, which, of course, forms a very good flux for the strongly basic gangue of the ore.

Under the particular operating conditions prevailing at the Aosta works — especially in relation with the raw materials available there — the pig iron best suited to blast furnaces, acid converters, and subsequent electric refining, contains about 4.3% carbon, 1.5% silicon and 0.80% manganese. (In this iron, sulphur and phosphorus combined are below 0.03%, an unusually favorable figure.)

Molten iron remains about 24 hr. in the electric mixer, where it loses about 0.5% carbon; it is then blown in the converters. Converter metal finds its way into the following three classes of products:

1. A small tonnage is cast directly into steel ingots, following ordinary practice. This tonnage is quite variable and depends on the amount of liquid steel required for the continuous operation of the electric refining furnaces. As the latter must produce a great variety of special steels, requiring very different periods of time for the refining and finishing operations, their output — and the tonnage of blown iron required by them — is far from being constant. This first part of the products of the converters

is, therefore, to be considered simply as a necessary by-product of the normal production of the electric furnaces.

2. As noted above, the bulk of the production from the converters goes directly to the electric furnaces, where it is finished into high quality special steels. For this purpose, the wind in the converters is stopped before carbon, silicon and manganese are entirely eliminated. By properly choosing this stopping point, a product is obtained which can be rapidly refined and finished in the electric furnace.

Ordinarily, three converter heats are required for one electric furnace charge. Charging, therefore, requires 30 to 35 min.; subsequent operations require from 1 to 2 hr. more, according to the composition and quality of the final steel. Under such conditions, and in normal running, a 25- to 30-ton furnace can produce about 300 tons of special steels daily, perfectly deoxidized and refined.

3. A final portion of the converter product is used for the manufacture of special pig irons. By stopping the wind at the right point, making the proper additions of alloys in the converter or in the ladle, by mixing in given proportions the different products so obtained, and by adding eventually some blast furnace iron from the mixer, all the special pig irons required by the market can be prepared under the most economical and best technical conditions.

It must be admitted that Cogne possesses a most interesting plant, containing not only some advanced electrical equipment but also operating in a unique manner to produce essential steels for Italian industry.

FEDERICO GIOLITTI

Turin, Italy.

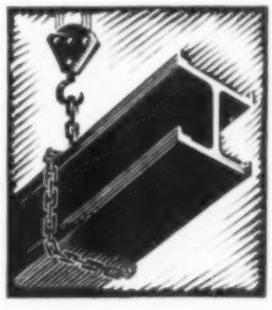
Repairing and heat treating chain slings

SINCE the *Transactions* of the American Society for Steel Treating have, in times past, carried more than one contribution on the care and maintenance of crane chains, readers of METAL PROGRESS may be interested in a few notes on experience with this type of gear in Australia.

This year the arch bridge across Sydney Harbor, New South Wales, will be opened for traffic, thus completing a project whose construction started in 1924. Heavy plates and angles for this bridge were rolled at the Redcar works of Dorman, Long & Co., Middlesbrough, England, but the light structurals were made in Australia. All fabrication was done in large shops erected at water's edge near the bridge site.

In all, over 50,000 tons of steel have been erected in this 1,600-ft. bridge, thus making it the longest and heaviest in the world, probably sharing this distinction with a similar arch under construction at the Port of New York. Individual members in the Sydney harbor bridge weighed as much as 120 tons. Special lifting yokes were bolted to these heavier pieces for handling in the shop and during shipment and erection.

All chain gear used in the workshops and on the unloading wharf was made in the local bridge shop at Milson's Point from commercial iron chains, supplied with test certificates by the manufacturers. End-links, rings and hooks for all of these were made of mild steel bars.



At first, it was planned to anneal every chain at monthly intervals, but every chain so treated broke in use within three days. The practice was abandoned, of course, when this fact was established. In its place, a monthly visual examination was carried out. Links showing any signs of opening at the scarf were removed, as were those showing deep cuts from contact with plate edges. Only where there was obvious distortion and over-stress was heat treatment indulged in, and then the chain was normalized.

When it was necessary to renew any links, mild steel was always used, and we are proud to record that in five years' continuous and severe service, not one steel link has broken, and not one accident has occurred which can be blamed on a broken chain. Welded steel proved quite equal to the demands put upon it.

Welding practice adopted for making these mild steel chain links has been as follows: First, scarf and shape the link; then raise the open link to a welding heat and weld the point of each scarf with the ball of the hand-hammer only. Another welding heat was then taken and the weld finished with a heavier hammer. Finally, a lower heat was taken to shape the link and the weld was swaged until it was almost black.

Repaired chains were then put into service without any further heat treatment. On testing some of these links by closing them together under the power-hammer and afterwards forcing them apart with a chisel, the resultant fracture showed a complete absence of enlarged crystals usually associated with welding heats on steel. We attribute this fact to the final swaging at a low heat, which in effect is a grain refinement by mechanical work.

ARTHUR S. REARDON

Newton, New South Wales.

French special steel industry migrates north

IN THESE 16 years since the outbreak of the War, we have witnessed a wonderful development in the electrometallurgy of iron. Yet the furnace created long ago by Heroult, that inventor of genius, is employed in constantly increasing measure, and without any material alteration (except having generally adopted the convenient Soderberg continuous electrode).

So it happens that practically all the electric steel tonnage is manufactured today in arc furnaces, either of the Heroult type or arc furnaces having a conducting hearth. Thus it seems that such a wonderful development in steel making was not provoked by a great transformation in the apparatus as orginally created and used. Consequently, it is interesting to consider the economics of the situation, and to point out its principal factors, confining our study to Europe and more especially to France.

From the first, the new processes have been divided into two classes:

1. Manufacture from solid charge in arc furnaces with cheap current, and consequently in plants erected in mountainous regions (the Alps and the Pyrenees), where hydroelectric power is available.

2. Manufacture from molten charge in induction furnaces, frequently obtaining only an additional refining of steel, economically and in large tonnage.

These processes were originally installed by technicians to whom is due praise for remarkable skill and tenacity. But in general they were electrical or mechanical engineers rather than metallurgists. This insufficient knowledge of steel works practice was responsible for conditions which could not be corrected except after a long and difficult campaign. The steels obtained under such early conditions compared to poor advantage with other products of quality, a circumstance which competitors cleverly improved to compete with the product of the electric furnace and to discredit its products.

But little by little, the technique of manufacture has been improved and established. This has come about by collaboration of "practical" steel makers and the advancing scientific knowledge of the chemistry of steel refining. It results that the electric furnace has actually succeeded in forcing itself into the first place in the view of producers of steels of the highest quality.

Even those persons who did most to bring it into disrepute — the metallurgists of the Loire

and of the Center of France — all have installed electric furnaces in their steel works. The process has consequently victoriously broken into that part of France which has always and rightly been regarded as the source of the best steel. This high reputation had to be maintained, and for this very reason the progress of electric steel was impeded more in France than anywhere else.

At the present time, the electric furnace can compete with the two older proceses used for refined steel — crucible melting and open-hearth refining. It can give products of a quality equal to crucible cast steels, but at a cost scarcely higher than the open-hearth steels (and a great part of the cost is due to the energy required to melt the solid charge).

Thus can be explained the wonderful development of electric processes for refined and semi-refined steels. One may discern two important trends showing the further evolution of electric methods for steel making:

1. The use of the high frequency induction furnace. We do not know yet how this equipment can be economically used for refining impure metal. However, it takes the place of the old-fashioned crucible process in the melting of pure raw materials. It has been adopted for this purpose at the most famous French steel works making crucible steels: J. Holtzer, at Unieux.

2. Its use, duplex, working a molten charge. For this practice, it is necessary that the furnace be charged with molten metal produced in the cheapest way. These circumstances oblige the furnace to be erected in the vicinity of a Bessemer converter steel works, the blast furnaces of which can supply electricity at a very cheap rate. (It is worth mentioning, however, that treatment of properly blown metal reduces the current requirements to a small quantity.)

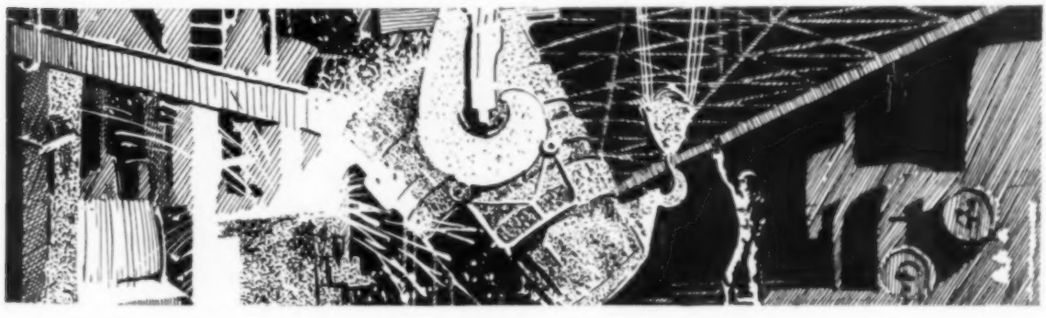
These reasons have contributed toward the construction of some new plants in France. While they are not yet completed, the electric steel works of Thionville, Hagondange and Ugine-Uckange may be mentioned.

This geographical emigration of the electric steel works from the Alps, and the special steel works of the Center, to the East and the North of France, is one of the most characteristic and remarkable events in French metallurgy today.

Perhaps in these new works the anticipated decrease of the cost of production will permit electric steel to penetrate into some spheres (such as the railway industry, the big mechanical and electrical shops) where ordinary and semi-refined steels are now used. If this be true, these industries would then profit by all the advantages that steel of quality can give.

ALBERT PORTEVIN

Paris, France



A NEW . . .

FORGING DEFECT

ITS CAUSE AND CURE.

By W. E. Jominy and A. M. Steever

A SURFACE DEFECT on forgings has from time to time come to the attention of the authors which does not appear to have been investigated and described anywhere in the scientific literature. Nevertheless, it causes very considerable trouble and loss to forging plants and their customers.

This defect occurs in small, irregular areas or patches at one or more points on the forging. Usually only a minor percentage of the forgings produced from a given furnace is affected.

Some furnaces seem to be guilty culprits; others produce blameless forgings. Alloy steels seem to be more affected than plain carbon steels. These surface blemishes are of such a nature that, unless each forging is inspected for superficial appearance after pickling, they would probably not be detected. They will be encountered and make themselves very evident, however, if the forging is subsequently machined, because the spots are hard enough to cause serious trouble with the tools.

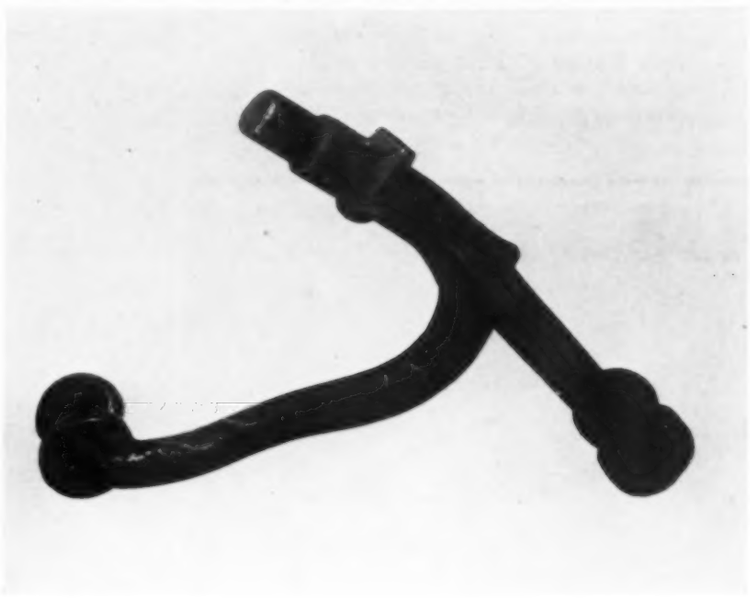
A sample forging from a number which had been rejected on account of such defects is shown in the two figures on the opposite page, where defects on one arm are marked out between light chalk lines.

In view of the importance of the phenomenon, a study was made (as part of the research program on forging directed by one of the authors and conducted for the American Gas Association) at the Department of Engineering Research, University of Michigan, Ann Arbor. As a result of this investigation, we have found the primary cause of the trouble to be a localized carburization, occurring during heating the bar stock or billets in the forging furnace. This fact was discovered by sectioning some of the defective forgings and examining them

under the microscope. In every instance the surface of the steel was found to have been carburized at the defective area, although it was usually decarburized at other surface regions close to it.

This condition was clearly shown in a considerable number of photomicrographs, two of which are reproduced on page 96, and may be regarded as typical of the structures found in many forgings with this defect.

The micro at the left shows the condition at the defective spot on the surface, and the one on the right the microstructure of a good portion of the surface near this blemish. It will be noted that the edge of the section shown in the former is deeply and heavily carburized; it is also very rough and irregular, probably from melting at this edge. The edge of an adjacent area is clearly shown to be decarburized, but to a comparatively superficial extent. In other words, this sample was *carburized* in areas adjacent to decarburized areas, this phenomenon occurring presumably in the same furnace at the same time. As remarked above, the two views are typical, the same phenomena were found in other photomicrographs which were taken from other forgings.

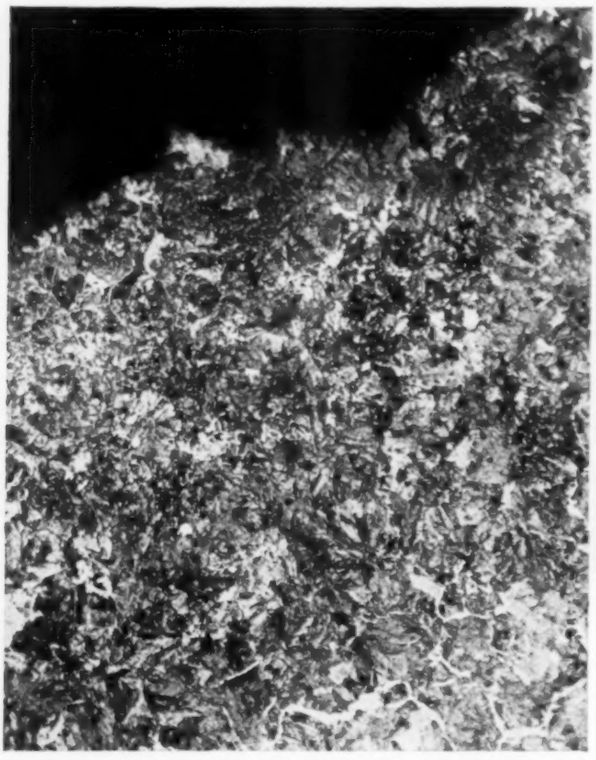


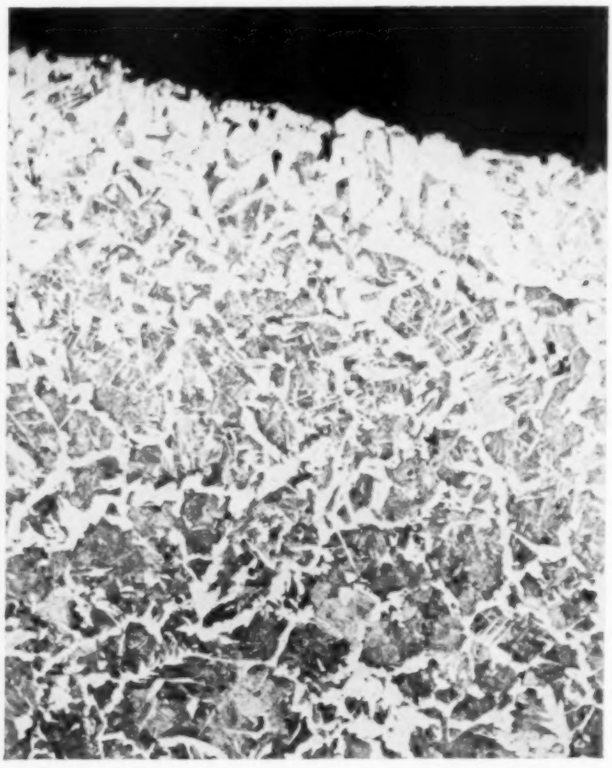
Above Is a Photograph of a Forging Which Has Two Surface Defects on Its Horizontal Arm of the Type Discussed by Messrs. Jominy and Steever. Chalk marks encircle the blemishes, a close-up of one of them being shown below. Frequently such troublesome hard spots are not found until the forging is pickled or reaches machining operation.

The question at once arose as to how a bar of steel could be carburized and decarburized at adjacent areas at the same time in the same furnace. It had been suspected that these bad forgings came from a certain spot in the furnace near the burner, and this point was placed under careful observation. It was found that the defects occurred most frequently in the furnaces having automatic control where the oil burned with a smoky flame during part of the time.

Looking for some source of intense local carburization, we found small lumps of coke near the burner, apparently formed from the oil. When one of these lumps of coke was

Microsection Through One of the Surface Defects. This photomicrograph shows the steel to be heavily carburized at the defective area. Magnification 100 diameters.





Photomicrograph at Another Portion of the Same Forging Showing the Steel to Have a Decarburized Skin at This Point. There was no defect where this section was taken. Magnification 100 diameters.

placed against the steel and heated, the steel appeared to fuse at the point of contact, and the final appearance of the surface was very similar to the defect under study.

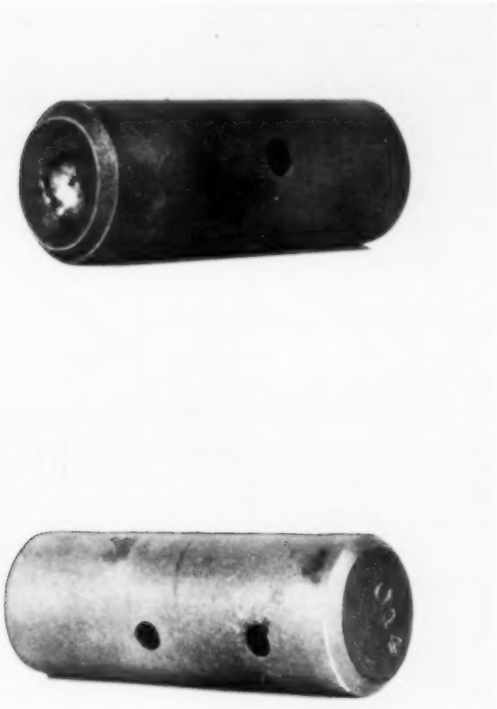
To verify our suspicions that carbon from the fuel is the cause of this forging defect a test was made in a laboratory furnace using a sample of chromium steel, which appeared to be more susceptible to this trouble than other steels. Its analysis was as follows: Carbon 0.29%, chromium 0.84%, manganese 0.73%, sulphur 0.025%, phosphorus 0.016%, and silicon 0.18%.

The sample was machined to a $\frac{3}{4}$-in. round rod and pieces cut 2 in. long. One test piece was drilled with two holes $\frac{3}{16}$ in. diameter, one in the end and the other at the center. Coke collected from the oil furnace was placed in the hole at the end, and carbon in the form of lampblack in the hole at the side.

This sample was then put into a muffle furnace, heated for 40 min. to 2,375° F. in an atmosphere containing one part city gas and one part air. The steel was then quenched in cold distilled water.

Examination of this sample showed that the core had melted at the end into which the coke had been put, although there was no sign whatever of fusion elsewhere except that the hole in the side, into which the lampblack was placed, showed slight fusion on its inner surface. The top figure on page 97 shows this condition, the surface of the hole in the middle being in much better condition than the one at the end.

This experiment was repeated at 2,300° F. instead of 2,375°. In this heat the sample was drilled sideways with two holes. Metal around the hole containing the coke from the oil furnace melted even at this lower heat, whereas no fusion occurred at the surface of the hole



Top Is a Sample of Chromium Steel After Heating to 2,375° F. A hole in the end the same size as that in the middle had been filled with coke from the oil furnace, while the hole in the middle had been filled with lampblack. The lower sample was heated to 2,300. Hole filled with coke shows slight fusion; hole filled with lampblack is clear.

containing lampblack. This is shown in the lower photograph on this page.

A further test was made in which plain carbon steel was used in place of the chromium steel; the temperature employed was 2,375° F. With this steel at this higher temperature only slight fusion was produced with the coke from the oil furnace and none with the lampblack. This checks the practical finding that chromium steel is more susceptible than carbon steel to the defect.

It will be observed that all the evidence points to the carburization of the steel by contact with coke formed in the oil-fired furnace. It may also be possible that a shaft of oil or oil vapor could strike the steel placed near the burner and carburize it in a limited area, even though the atmosphere is decarburizing.

It is, of course, well understood that the melting point of steel varies with the carbon content; the higher the carbon content, the lower the melting point. Steel containing 1.7% carbon will begin to melt at 2,084° F., whereas a 0.35% carbon steel begins to melt at about 2,625° F. A forging temperature of 2,400°, therefore, will be perfectly satisfactory for a 0.35% carbon steel but will quickly melt a 1.7% carbon steel (if such an iron-carbon alloy can be called a "steel"). The point is this: When a steel is carburized, its melting point is lowered in proportion to the carbon in the carburized area.

It would appear that when in contact with coke from the oil furnace, the steel is carburized rapidly to a carbon content that will melt at 2,300° F. If carbon is in the form of lampblack, however, a sufficiently large amount of carbon cannot be absorbed to cause melting at 2,300°, but will cause melting at 2,375° F. These temperatures apply to the chromium steel used in these tests.

When a plain carbon steel is used, such as S.A.E. 1020, it has been found that coke from the oil furnace will barely cause fusion at 2,375° F., and lampblack will cause no fusion at the same temperature.

Since only part of the carburized portion melts, there is left on the steel a carburized spot which will cause difficulty in the machining operation. The carbon content in the forgings examined has been above 0.90% at the defective area, and will, of course, be very troublesome when machining such a metal as the chromium steel used in these tests.

To eliminate this difficulty it is therefore necessary

(a) To prevent or minimize the formation of the coke in the oil furnace, or

(b) To prevent the coke from coming in contact with the steel.

To prevent the formation of coke the oil furnace may be fired with an increased quantity of air, but this may result in excessive scale formation. If the latter contingency appears and must be eliminated, care must be taken to remove the coke from the furnace at frequent intervals and to place the bars in the furnace at a distance from the burner, or to take other steps to prevent the impingement of liquid oil or strongly carburizing oil vapor on the stock.

. . Staff Article . .

THE ANCIENT AND HONOURABLE ART OF NEEDLE MAKING

BEFORE the time of the Industrial Revolution, when skilled craftsmen manufactured their products by hand, there lived many needle makers whose ambition it was to make a perfect set of needles. One of them was better than the rest. For many years he labored, making better and better needles, but his honest eye recognized each set imperfect in some slight detail.

Nevertheless he persevered and at last produced a set which was perfect. Strong and resilient they were, with polished surfaces, smooth eyes and sharp points. Months had been spent in producing this one set. The old man was exceedingly proud of his handiwork; he would take them out of an inner pocket and gloat over them as a miser his hoard. Yet he kept the needles hidden, showing them to no one. Then one day he threw them away.

Some time later he told his friend about them—how he had worked and loved them and how he had finally destroyed them. The friend was horrified. "Why did you do it?" he asked.

"If I had kept them and shown them to others," the wise old man answered, "everyone else would have wanted some like them. I could not have sold the needles which can be quickly made. It takes years to make perfect needles, and I must earn a living!"

But that was two centuries ago, and now needles are manufactured hundreds of thousands at a time more perfect than the set the old needle maker took a lifetime of skill to produce by hand.

Crude needles, however, have been known since the earliest prehistoric civilizations. These were far different from the ones now in use. In fact, they were not needles at all, but awls used for piercing holes for thongs or vegetable fiber threads.

One of the earliest pierced needles was a walrus tooth with an eye in the center. Stone needles with holes in the end opposite the point have been found in remains of the Stone Age. Needles of sharp thorns, pieces of wood and ivory, fish bone, bird's bone and horse's bone were used by the ancients. Bronze and copper needles 2½ to 8 in. long have been found in Egyptian and Scandinavian tombs of 4,000 years

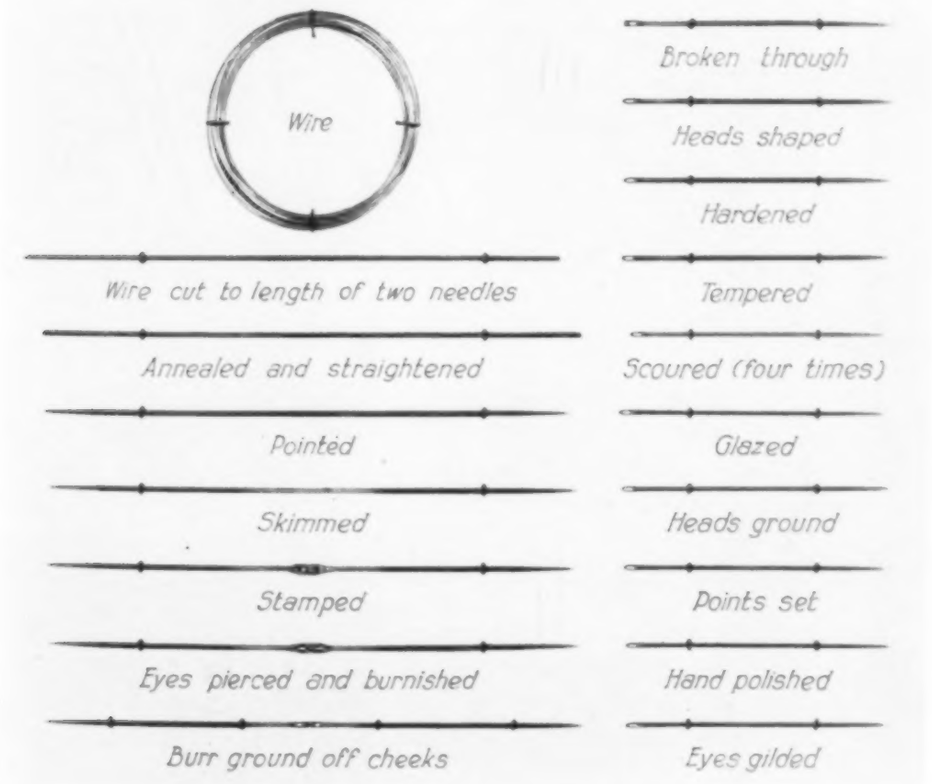
before Christ. The sketches of some of these relics printed on pages 100 and 101 are from a book describing the ancient tools and implements in the University College collection, London. Many of them were discovered by the author of that book, W. Flinders-Petrie, the eminent Egyptologist, who has depended upon such fragments to reconstruct the historical and cultural relationships of the old civilizations.

The invention of the needle has been ascribed both to the Roman goddess, Bellona, and to the Chinese; however, it was used in cruder forms many centuries before either of these civilizations.

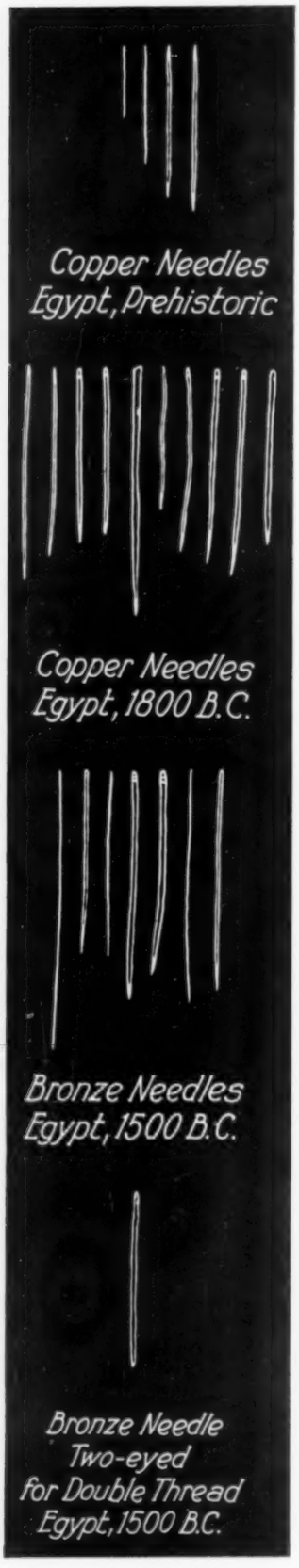
Steel needles were first introduced into Europe by the Moors at the time of the Saracen invasion and were manufactured in Nuremberg as early as 1370. Although England is now the needle center of the world, the industry was not begun there until the time of Queen Elizabeth, about 1560. For a long time the process was a secret one; as in other crafts the essential information was given to apprentices only after long indenture. It was known in England only by a Spanish negro and later by Elias Krause, a German, who died keeping the secret. No more English needles were made for 100 years until 1565 when Cromwell organized the Company of Needlemakers.

Manufacturing methods at the beginning of the eighteenth century were very crude. Water power drove the simple machines which prepared and pointed the wire, a hand-operated cutter resembling a pair of overgrown pliers was used to cut it into desired lengths, and square eyes were punched by hand. Machine methods for cutting the wire were introduced about 1760. The first eye drilling machine was invented in 1826, and two years later machines for burnishing the eyes were installed. With the introduction of a polishing machine in 1839, a great deal of hand labor was eliminated.

Heat treatment necessary to impart to needles their resilience is a delicate operation; the amount of metal in a single one is so small that it responds to variation in furnace tem-



Various Steps in the Manufacture of Needles as Practiced in Redditch, England. Unfortunately the half tone does not show the high polish acquired by the needles during the last operations.



perature almost immediately. Furthermore, surface condition is of utmost importance, so scaling must be kept at the absolute minimum. The necessary hardness was formerly secured by water quenching; the needles so treated were brittle and easily broken, so in 1840 water quenching was superseded by oil hardening, rather an early date for this "innovation" in heat treating. In an old encyclopedia of needlework is given this test for a good needle: "To test a needle, try to break it between your fingers; if you feel it resist and then snap clean in two, the steel is good; if it bend without breaking or break without any resistance, it is bad."

The test is still a good one and is now generally used in the manufacture of springs, where it is known as the "break test." The spring strip is formed into a loop and squeezed, either by hand or, for heavier pieces, in a vise, until it breaks. The quality of the strip is judged by the amount of snap, the squeeze required to bend it, and the shape and glitter of the fracture.

The center of manufacture of hand-sewing needles is the town of Redditch, England, where conservative manufacturing methods are practiced. This region supplies nearly all the requirements of the civilized and uncivilized world. If you go into a Woolworth store you will find that the packets bear the mark "Redditch."

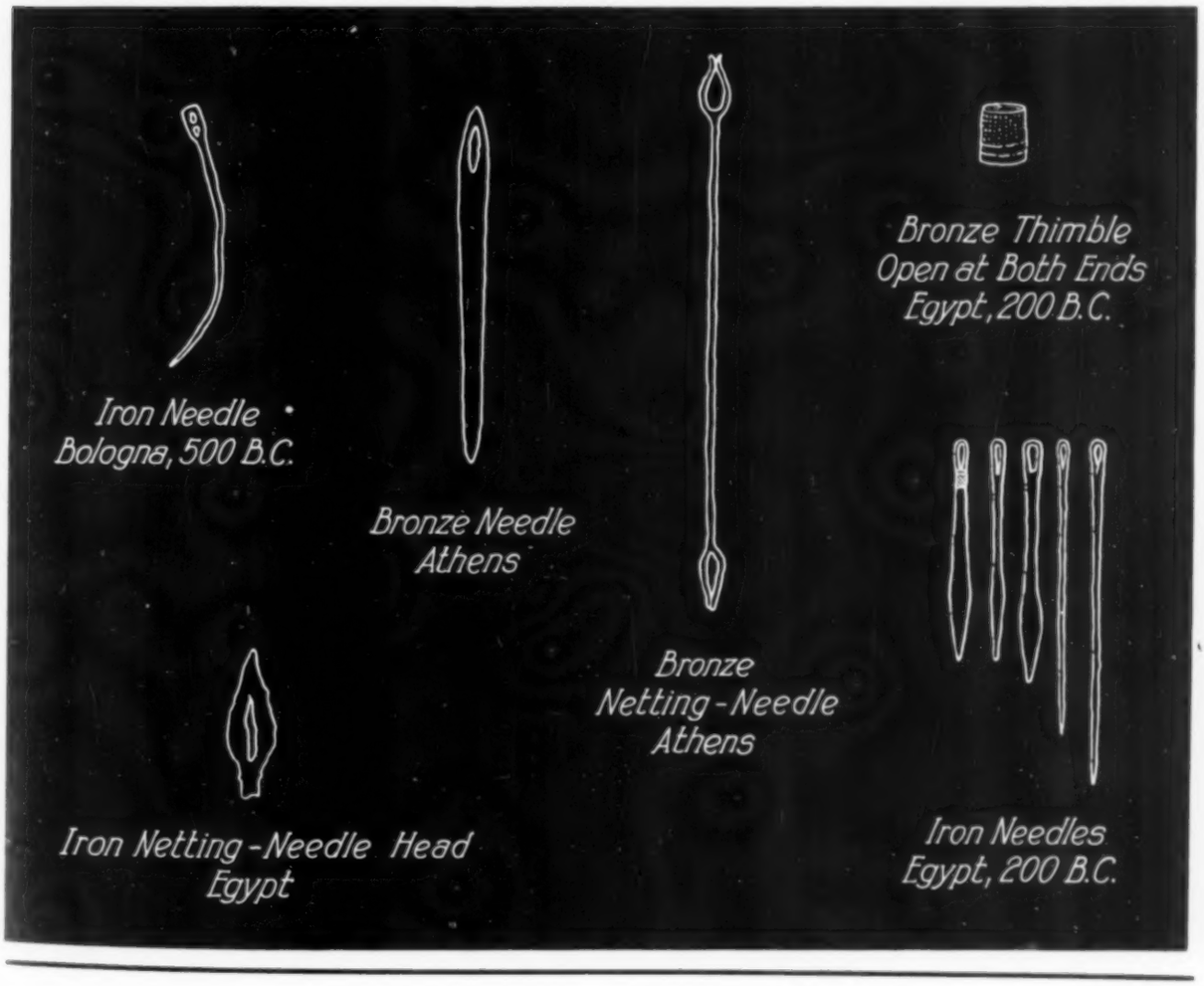
High-grade crucible cast steel of 0.85 to 1.1% carbon, manufactured in Sheffield, is used to make the wire. It is hot rolled into rod and cold drawn into wire. Diameters range from 0.014 to 0.006 in. The wire is uncoiled and cut into lengths of correct size for

two needles, packed into bundles of 72,000 wires, enough to make 144,000 needles, and delivered to the needle maker at Redditch, who thereupon proceeds to manufacture according to the operations shown step by step in the photograph on page 99.

The first process on this raw material is known as "rubbing" and has the combined effect of straightening and annealing the wires. A bundle of wire is heated to a dull red heat. Then a steel ring is placed over each end and laid on a flat steel plate having parallel grooves to guide the rings. The needles are pressed against the plate and rolled backward and forward by means of a curved iron tool having two longitudinal slits through which the upper rim of the rings project. In this way they are made to straighten each other, while the slow cooling of the wire is in effect an anneal and produces uniformity of chemical and physical condition by this highly ingenious procedure.

Pointing is a semi-automatic operation. The "stiffs," as the annealed wires are called, are fed one after another over a concave grindstone, by means of a rubber-faced wheel set at 90° to the stone. The curvature of the face of the grindstone and the inclination of the rubber wheel controls the contour at the end. The presence of an operator is necessary to prevent the needles from jamming or crossing. Both ends of the wire are pointed successively in this way.

Formerly the pointing was done by hand by a workman who held a bundle of the wires up to the wheel. The fine dust of steel and abrasive inhaled by the workers attacked their lungs and made "Pointer's Asthma" a common malady — another of those occupational diseases akin to tuberculosis. Now, of course, ventilating tubes which suck away most of the injurious dust are



installed in the needle factories. A local by-product of the industry is made from this dust. It is used for garden paths and walks because it packs down into a hard resilient surface, but it is impracticable for road surfacing because of the tendency of sharp points of steel, which are rather hard on horses' hoofs and automobile tires, to work to the top.

Eyes are punched in two operations, as shown on the card, page 99. The wire must first be stamped in the center for the eyes of the two needles; otherwise, the drill would slip off the sides of the round wire. The machine stamps and punches 7,000 blanks (14,000 needles) per hour. The burrs are then ground off and the heads shaped on a small abrasive wheel. Before breaking the two needles apart, they are strung on a flaxen thread covered with oil and fine emery, and swung around, thus polishing the eyes to a smooth finish so that they will not cut thread in sewing.

Needles are broken apart by hand by women, one good worker being able to break off 2,000,000 needles a week.

Heat Treating Process

Heat treating consists in hardening and tempering. The needles are heated to a red heat in muffles and quenched in cold oil. They are tempered by being passed slowly over small gas flames which heat them to a blue heat (about 600° F.), and are cooled slowly. Finish tempering is provided by the heat generated in subsequent polishing operations.

At this stage the needles are rough and discolored. They are scoured, polished, ground and glazed in many operations using polishing mixtures having a fine emery base. One firm in Redditch has a polishing process which lasts a week. A mixture of emery, soft soap and water is added to a bundle of needles tied into a canvas covering. The package is rolled between moving runners and a solid table faced with steel continuously for seven days, during which time the needles travel a distance of 30 miles. They are then washed, and dried in elm sawdust to prevent oxidation.

One wonders with what scorn a proposal would be met to use some other variety of sawdust. Elm sawdust might get scarce. Why not yew, or oak or willow? Or pine, or fir or hemlock? Needles for the best trade might be dried in mahogany or ebony or walnut! Doubtless each has its specific action on steel.

Eyes are finally cleaned by means of jeweller's rouge applied with brass bristles.

Needles are sorted by rolling down an inclined plane which brings the heads all in one direction, since the pointed ends travel more slowly than the thicker ends. Sorting was formerly done by a woman whose right hand was wrapped in a rag. Pressing her palm against the needles caused the points to stick to the cloth as she raised her hand. Grading, however, is still done by hand by deft-fingered women who can recognize defectives merely by the feel of them. Hand methods are also necessary in the manufacture of very fine lace and bead needles, particularly in filing off burrs from tiny eyes.

Needle making requires, as may be seen, more individual skill than is ordinarily found in these days of machine-made products.

Needles are packaged in papers of 12, 25, 50 or 100, either in assorted sizes or all of one size. Better grade needles have gilded eyes which are warranted not to cut the thread. Gold and silver needles are used almost entirely in the tropics. These of course are of hard drawn wire, such metals not responding to heat treatment, in the sense that steel does.

U. S. Needle Industry

Specialized types of needles, which call for alloy steels and special methods of manufacture, are largely made in the United States. Few if any hand sewing needles are made here. Hypodermic needles are of seamless tubing (manufactured by the Summerill Tubing Co., Bridgeport, Pa.), so fine that it can easily puncture the skin. Stainless steel is used for these and other surgical needles. Phonograph needles are frequently of tungsten steel, and latched needles, used in stocking machinery, which are softer than ordinary varieties, have a carbon content of 0.50 to 0.80%. American sewing-machine needle manufacture differs from English hand needle methods chiefly in the forming process (they being swaged between steel dies from large diameter blanks one-third the length of the finished needle) and in the greater prevalence of machine methods over hand labor.

SIMONDS STAINLESS

STAINLESS IRON

18 PER CENT CHROME . . . 8 PER CENT NICKEL ALLOY . . . . . WE ARE NOW EQUIPPED TO FURNISH STAINLESS IRON IN SHEETS OR BARS OR IN STRIPS UP TO 8 INCHES WIDE . . . . . WRITE US REGARDING YOUR REQUIREMENTS . . . . . .

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IS ALSO A RELIABLE SOURCE FOR . . . . . CARBON, HIGH SPEED AND TOOL STEELS . . . HIGH GRADE PERMANENT MAGNET STEELS . . . INCLUDING COBALT GRADES . . . . . LOW EXPANSION NICKEL STEELS . . . . . HEAT RESISTING METALS . . . . . .

SIMONDS STEEL MILLS

SIMONDS SAW AND STEEL COMPANY

LOCKPORT **NEW YORK**

(Continued from page 56) the older forge processes are adequate for the minor uses to which such products are now put, but these uses do not include joints having high predetermined efficiency. No unit basis has been suggested for rating the physical properties of forge welds, made by hand on an anvil.

In all resistance welding processes the efficiency of a joint depends primarily on the suitability and the adjustment of the machine employed for each specific purpose. If the electric power is too high, or its duration too long, the metal will be overheated. If the mechanical pressure is too high, the length or the cross-section of the welded material will be excessively reduced. If either of these factors is too low, no union will result. With an adequate machine that is kept in proper adjustment any resistance process produces a weld whose strength and ductility are substantially equal to those of the parts united.

Physical properties of resistance welds are determined in a different manner than for most of the fusion processes. For instance, the efficiency of an individual type of joint welded by electrical resistance duplicates what has been found to result from the employment of an automatic machine specially designed to suit that type of joint considered as a whole. On the other hand, in fusion welding the efficiency of a joint, in terms of some unit of its area, is predicated on tests that have been made on similar joints (but not necessarily duplicates), made by a similar method, but not necessarily with the same equipment. In both processes qualification tests should be applied; test the machine for resistance welding; test the operator for fusion welding.

Strength of welds made by either the gas or the arc fusion process may reach almost any desired amount, depending on the details of the process and on the grade of weld metal used. If the rod is a suitable grade of soft or medium steel, the tensile and shear properties of the welded joint may be conservatively expected to average approximately as shown above.

Ultimate tensile strength	50,000 lb. per sq. in.
Tensile yield point	40,000 lb. per sq. in.
Ultimate shearing strength	36,000 lb. per sq. in.
Tensile modulus of elasticity	29,000,000 lb. per sq. in.
Shearing modulus of elasticity:	
G (American double basis)	10,500,000 lb. per sq. in.
*E*2 (Metric single basis)	21,000,000 lb. per sq. in.

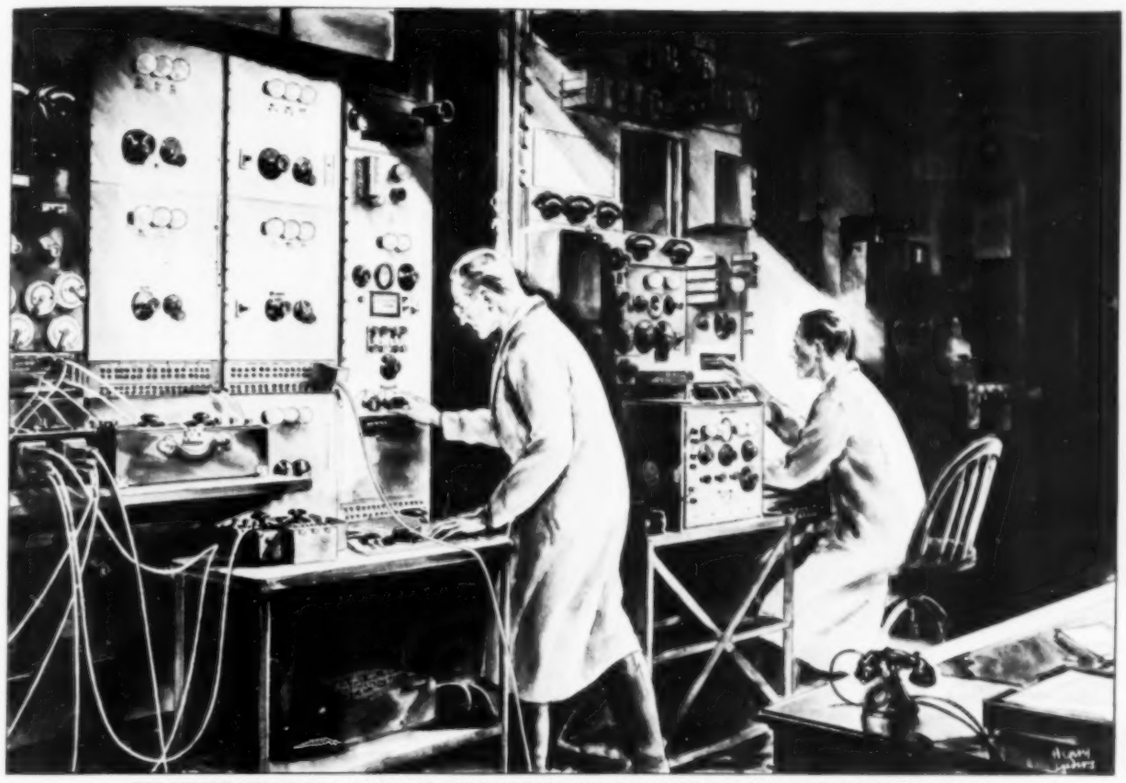
In general the ductility of a gas weld is higher than that of an arc weld produced in the ordinary manner with bare filler metal, but the ductility of either may be improved by the several means previously described.

The resistance of fusion welds to shock and fatigue has not yet been fully determined on a unit basis, but many joints made by these processes have been subjected in industrial service to severe impact, over long periods of time, without showing sign of distress. Experience indicates that a weld whose length is parallel to the direction of stress will resist shock better than one disposed transversely.

Ultimate tensile strength of an unworked thermit weld, not heat treated, made with an ordinary mixture of thermit metal, may be placed at about 70,000 lb. per sq. in., with an elongation in 2 in. of 20 to 25%. By suitably varying the composition of the mixture, welds having lower strength and higher ductility, or vice versa, as well as great resistance to wear, may be secured. Thermit welds stand up very satisfactorily under drop test.

Fields of Use. Two basic methods other than welding have long been employed to unite metal parts for the purpose of transmitting stress. One is a mechanical operation in which a portion of each part is first removed, in the form of round holes, slots, threads or other openings, and the removed metal is then replaced by interlocking pieces in the form of rivets, bolts, nuts or keys. The other method depends on surface friction between the parts, the friction being produced by mechanical pressure while the parts are cold or by the thermal shrinking of one part after it has been heated. Both of these methods reduce the available strength of the parts.

The fields to which the several welding processes are applicable are those in which it is



THE STEADY SCIENTIFIC PROGRESS OF THE BELL LABORATORIES SHOWS IN THE EVER-INCREASING QUALITY AND SCOPE OF YOUR TELEPHONE SERVICE

To clear all barriers for the human voice

An Advertisement of the American Telephone and Telegraph Company

Bell Telephone Laboratories, Incorporated, is the scene of a progressive conquest of natural forces that aims to let you speak clearly, quickly and cheaply to any one, anywhere in the land and even to distant countries. More than 5000 scientists and assistants are busy there and elsewhere in the Bell System studying the problems of sound transmission. Its work is the growing foundation of the telephone art; and it has, besides, helped to make possible the radio, sound pictures and special apparatus for the medical profession.

Among its achievements are the underground cables which make city telephone service possible, better and faster long distance service, service to ships at sea, and to millions of telephones beyond the seas. The steady scientific progress of the Bell Laboratories shows in the ever-increasing quality and scope of your telephone service. Its new developments in every type of equipment clarify and speed up your telephone talks and give you more and better service at low rates. Every advance it makes is available throughout the Bell System.

The Bell System is an American institution owned by more than 500,000 stockholders. It places before you the benefits of its technical achievements and the co-ordinated efforts of more than 400,000 trained workers. It accepts its responsibility to further the development and welfare of the nation by furnishing the public the best of telephone service at the least cost consistent with financial safety.

desired to avoid the loss in strength incident to the older methods and those requiring the joining of parts of greater or smaller size, more irregular shape or in a more restricted space than is otherwise feasible. In the union of parts subject to fluid pressure the welding process provides a joint which is tight at all temperatures and which appears to reduce local corrosion (and caustic embrittlement in boilers). To a large extent the fields covered by the several welding processes differ, but there is some overlapping.

The field of manual forge welding is limited to small objects. Quite large and thick parts can be welded under the hammer process illustrated on page 56. For a long time butt-weld pipe up to about 3 in. diameter, and lap-weld pipe up to about 30 in. diameter have been roll welded, while pipe up to 96 in. diameter has been hammer welded. These fields are now being invaded by electric resistance seam welding for the smaller sizes and by fusion welding for the larger sizes. All processes of forge welding as applied to steel require a lower carbon content in the base metal than is necessary under the newer processes.

Butt methods of resistance welding are suited to fields where a strong joint is desired. They are applicable to either thick or fairly thin materials. For some years single sections having an area up to 36 sq. in., requiring 900 kva. and a pressure of 100 tons, have been welded by a combination of flash and upset welding. This limit has recently been surpassed by the welding of solid steel shafting 8½ in. diameter and of 14-in. steel pipe with $1\frac{5}{16}$-in. wall, the respective cross-sections being 56¾ and 51 sq. in. A flash method is employed extensively in the joining of tubes and automobile rims and to unite the edges of sheets up to about $\frac{3}{16}$ in. thickness, as in the automobile bodies. Material whose edges are not exactly true can be welded by this process.

In theory, a spot process could be used to unite material of any thickness, but for very thick plates the enormous current and high mechanical pressure necessitates machinery so heavy as to be impracticable for most purposes. In addition it has appeared necessary to localize the spot area by means of buttons or other devices which so far have not proved commercially feasible. Therefore the field of spot welding has hitherto been restricted to thin material. A similar limitation formerly applied to seam welding, but recently improved methods have been developed, notably in the manufacture of pipe, which promise to raise the upper limit of weldable thickness to ½ in. and perhaps even higher. The percussive processes are especially suited to the multiple welding of different metals, or different grades of the same metal, as in the manufacture of automobile parts and tools, where it is desired to unite an expensive with a less costly portion. In all processes of resistance welding, except for very small parts, the weight of the welding machinery requires the work to be carried to the machine, and hence these processes are essentially factory operations. Their employment in quantity production is wide-spread. Based on value of product, probably three-fourths of all welding being done at the present time is performed by a resistance process.

While resistance welding is a rapid, multiple, manufacturing process, fusion welding may be called an engineering tool. Its field embraces all those applications wherein the strength of joints must be pre-designed on some unit basis, as well as a number of miscellaneous uses. In fusion welding also, except when full automatic machinery is employed, the welding equipment can be taken to the work, thus making the process suitable for both shop and field. It is quiet, thus broadening further the locations where it may be advantageously used.

The gas process of fusion welding is widely used in the production of pressure vessels from the largest sizes down to light drums, the joining of pipe, end to end, and to fittings, the manufacture of products of steel, ferrous and nonferrous alloys, the construction of aircraft, the repair of castings, maintenance of locomotive and railroad equipment, and in many other fields where its reliability and convenience make it suitable.

The metal arc process of fusion welding is well established as a production tool for welding the longitudinal seams of the larger sizes of pipe, the fabrication of pressure vessels, and in the construction of machinery bases and other parts. It is rapidly extending into the field of structural steel, where its simplified shop fabri-

cation requirements, its possibilities for saving weight in design, and its adaptation to all kinds of reinforcement are frequently important factors. It is used for a considerable amount of steel plate and shapes in ship and barge construction and for many other purposes where speed and economy are desired.

The fields to which the shielded arc, the electronic tornado, and the atomic hydrogen processes are applicable have been indicated in describing their operation. So far the gas cutting process has been limited to ferrous products.

The thermit process proper is used where great strength, ductility and soundness are required in the repair (and at times in the manufacture) of very large objects. It is available wherever a mold can be placed around the parts to be welded. Originally all thermit welding was performed by those developing the process, but in later years users have been encouraged to do their own welding. Crucibles and preheating torches are about the only special equipment needed. Mixtures of thermit metal, suitable as to grade and quantity for the purpose desired, together with tables giving all necessary data, are commercially procurable. The process is used extensively for the reclamation of heavy machine parts, marine rudder-frames and propellers, rolling mill equipment, and other important work. It extends to such special fields as rail-joints, where rails may be made endless either by the well known insert method, or the base and web may be welded by a thermit fusion method while the head is welded by a thermit pressure method in which the rails are drawn together by means of clamp bolts. A thermit pressure method is also used for jointing pipes up to about six inches diameter.

Technique. As may be inferred from the preceding outline, a definite technique is essential to secure the best welded objects, this technique differing with the various processes and with the purposes for which the objects are intended. Without the study and adoption of a proper technique disappointment and possible disaster must be expected. By the further development of a suitable technique, which should include the providing of proper jigs and fixtures to hold in place the parts to be united, the newer welding processes promise to extend to fields even broader than those now covered.

You would object if it was suggested that you use carburizing compound as a fuel.. Yet many plants are suffering large burning losses of carburizing compound, especially in direct quench and rotary practice.

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.. Will not continue to burn when discharged into the air from carburizing temperatures.

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TRY QUENCHING IT AT 1550°!

This is the most convincing test you can find to determine the natural toughness of straight carbon tool steel.

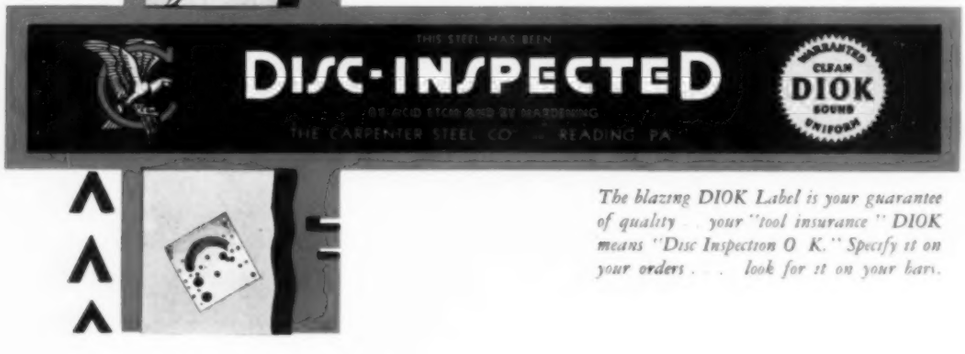
Tool steel which is inherently brittle makes good tools when everything goes just right, but if the design is not favorable . . . the hardening procedure is not perfect . . . or accidental overloads are imposed in service, it breaks. There is very little "factor of safety".

The tough kind, on the other hand, can be depended upon under all conditions, and has a much larger "factor of safety".

How then, can you tell the tough from the brittle?

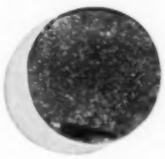
If you wanted to find out which of two men were the stronger, you would overload them with weights until the weaker man caved in. To determine the toughness of tool steels you give them a "heat overload" and see which will stand the most.

Almost any tool steel will look well when quenched at 1425° F but a steel of the brittle type will show grain growth, brittleness and may even crack when given only 50° or 75° overheat. The other type will withstand quenching from 1550° F or even 1600° F, and still remain fine grained and tough. It's a simple test . . . try it. You will see all the difference in the world when you break the hardened test pieces to examine them.



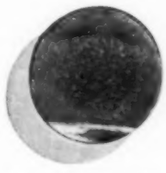
The blazing DIOK Label is your guarantee of quality . . . your "tool insurance" DIOK means "Disc Inspection O. K." Specify it on your orders . . . look for it on your bars.

BRITTLE • • •



The brittle type of Carbon Tool Steel looks like this when brine quenched from 1550° F. This fracture shows that it doesn't stand the "heat overload". Such steels make perfectly good tools when they get all the "breaks" but they crack readily in hardening if the tool design is unfavorable . . or if the heat is a shade too high. They check easily in grinding if the wheel is not just right. They spall, chip or break in service if they receive abuse beyond normal service conditions.

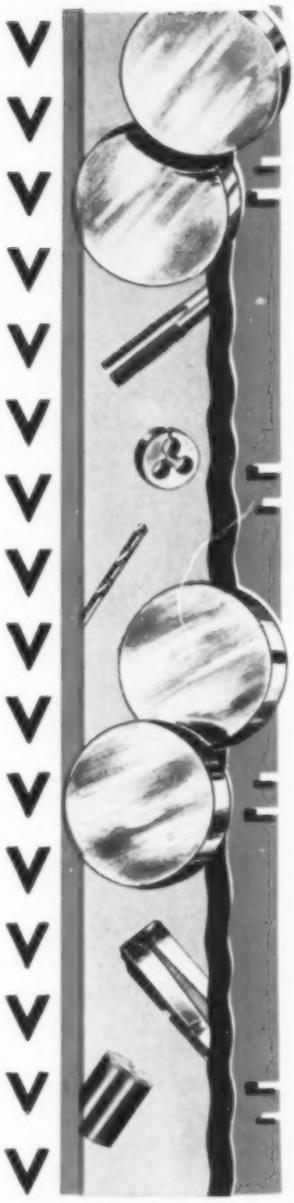
• • • OR TOUGH!



Tough Carbon Tool Steel looks like this after a 1550° brine quench. Such steels have a wide "factor of safety". They will withstand more unusual designs, and more abuse in hardening, are almost immune to checks in grinding, and the finished dies are rugged and tough, to withstand accidental overloads in service. All of Carpenter's new Disc Inspected (DIOK) Carbon Tool Steel is of the tough type. All of it will stay fine and tough when subjected to the "overheat test". We know this is true because for several years we have tested every bit of it that has gone into our warehouse stocks. And if it didn't pass the tests it was rejected.

This assured toughness is only one of the things you get by using DIOK Tool Steel. It is 100% Acid Tested to prove its freedom from injurious internal defects. It is tested at normal hardening temperature to prove that every bar has the same* hardness penetration. It is the best Carbon Tool Steel that money can buy, and it doesn't cost a cent more than other good carbon tool steels that have not had the advantages of these rigid tests.

** This is a part of our Timbre Test. "Timbre and How It Affects the Properties of Carbon Tool Steel" is the name of a new bulletin just published by our Research Department. It will be sent, gratis, on request.*



THE CARPENTER STEEL COMPANY

MILLS AND MAIN WAREHOUSES: READING, PA.

BRANCH WAREHOUSES:

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CLEVELAND 1515 HAMILTON AVE.	HARTFORD 3284 MAIN STREET	ST. LOUIS 4063 FOREST PARK AVE.

PHILADELPHIA, HORACE T. POTTS & CO., EAST ERIE AVE. AND D ST.

REVIEWS OF . .

RECENT PATENTS

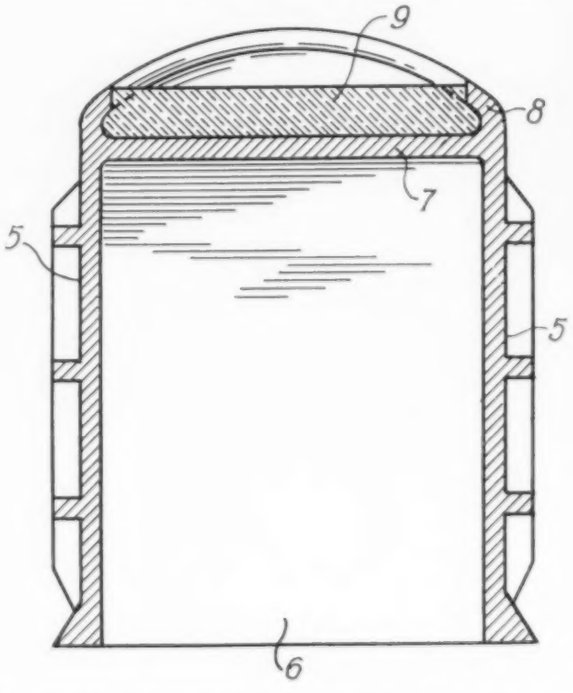
by NELSON LITTELL

Patent Attorney | 475 Fifth Avenue | Member of A.S.S.T.

Heat Treating Furnace, *by Clarence Winfred Spicer, Plainfield, N. J. 1,778,045; Oct. 14.* A heat treating furnace of the rotary type is described for use in heat treating tubes, bars, etc., of considerable length. The furnace has several units provided with central heating chambers, each unit being independently heated, and so that the heat may be varied in each unit. A mechanism is adapted to feed longitudinally the piece to be heat treated into the furnace with a positive rotary motion. A conical stream of cooling medium is provided, adapted to heat treat, anneal, and straighten the traveling tube while passing through the furnace.

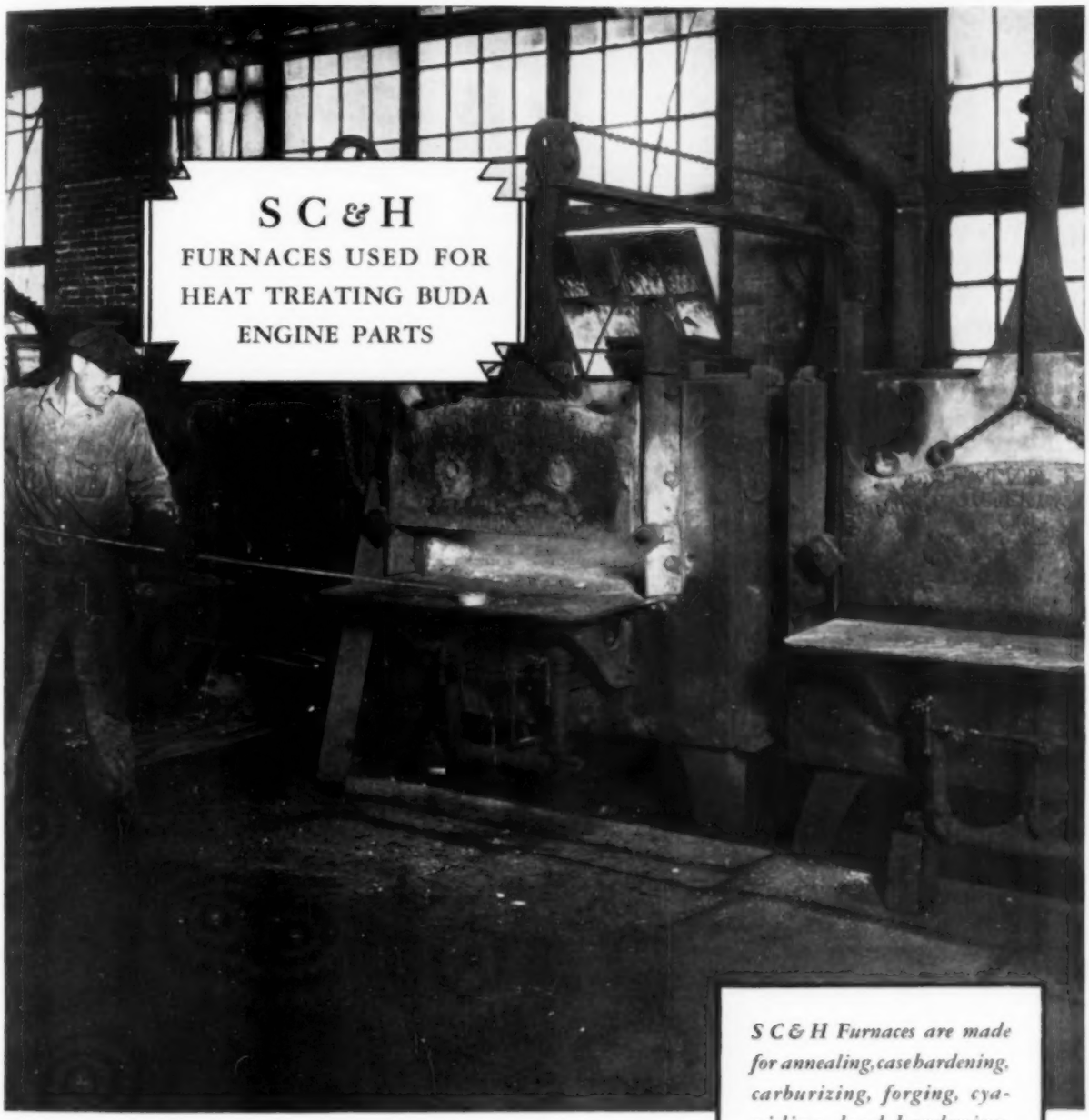
Protective Compound, *by Ludwig J. Christmann, of Jersey City, N. J., assignor to American Cyanamid Co. of New York. 1,779,961; Oct. 28.* The patentee describes an inhibitor for reducing the injurious effect of the pickle in treating iron and steel surfaces and discloses a condensation product of aldehyde ammonia and a thiourea compound. Such an inhibitor materially reduces the metallic loss and in general it is not necessary to use more than 1% of inhibitor in the bath. Thiourea compound is intended to include the various derivatives such as monophenyl thiourea, butyl thiourea and others.

Annealing Box, *by Matthew P. Wilson, of Cannonsburg, Pa. 1,777,595; Oct. 7.* This patent discloses an improvement in boxes used for annealing sheets or plates and in which the latter are stacked while being confined to a high temperature in the annealing process. As shown in the figure the sides *5*, and ends *6*, are of conventional and approved formation. The upper ends are curved inwardly for a slight distance above the ceiling *7* of the box as shown at *8* to provide a space above the ceiling in which



the insulating material *9* is placed. This insulating material may be any suitable non-conductor of heat which is lighter than sand. Such an insulator effectively protects the ceiling of the box and prevents overheating of the upper plates of metal within the box. The arched ribs conduct a sufficient amount of heat to the ceiling.

(Continued on page 112)



THESE two S C & H furnaces were purchased after six years of satisfactory service from two similar furnaces in the plant of The Buda Company at Harvey, Illinois. The two older furnaces are in regular operation and giving excellent results. Two pot type salt bath furnaces and one drawing furnace for this same manufacturer have been designed, built and installed by *Strong, Carlisle & Hammond* Engineers.

From the most modern type of tool room furnace to huge annealing furnaces for rolling mills, our Engineers offer an accumulated experience in industrial furnace design of great value to any plant operating or intending to operate its own heat treating department.

Our engineers will submit designs and estimated costs of an electric, oil or gas furnace to meet your plant's requirements at your invitation. The Strong, Carlisle & Hammond Co., 1382 West Third Street, Cleveland, Ohio.

S C & H Furnaces are made for annealing, case hardening, carburizing, forging, cyaniding, lead hardening, nitriding and oil tempering. They are built in all sizes of Oven, Pot, Continuous, and Special Types for Electric, Oil or Gas application.

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30 CHURCH STREET - - - NEW YORK, N.Y.

STRONG, CARLISLE & HAMMOND

MANUFACTURERS OF ELECTRIC, OIL AND GAS INDUSTRIAL FURNACES

Inductor Type Furnace, *by E. F. Northrup, assignor to Ajax Electro-Thermic Corp., Trenton, N. J. 1,772,579; Aug. 12.*

This invention relates to furnaces of the coreless inductor type. Its purpose is to secure maximum cooling for a turn of conductor having considerable extent parallel to the axis of the coil. The individual conductors may be air or water cooled and are connected in multiple in units of three, and as the coil sections are in parallel connection, the current flow will be increased. Such a construction provides an automatic power factor to improve efficiency.

Mold Wash for Nickel Ingots, *by A. E. Kayes and Fritz Moehling, assignors to International Nickel Co. 1,767,764; June 24.*

When casting alloys containing 30 per cent or more nickel, and especially when making ingots of pure nickel there is a considerable amount of splashing, and very often it is necessary to mill off from ¼ to ⅝ in. of the metal from the ingot in order to remove this rough surface. By the use of a suitable wash on the surface of the mold the amount of splashing may be eliminated or decreased. The wash consists of a mixture of powdered silicon and shellac including alcohol as a solvent for the shellac and the wash may be sprayed on or painted on the mold.

Spring Manufacture, *by William Wuerfel, assignor to Wilkening Mfg. Co., of Philadelphia. Re-issue No. 17,785; Aug. 26.*

A re-issue of original patent No. 1,668,297, which relates to the formation of springs of the flat annular type having a series of alternately reversed helical formations, and particularly made of cast iron adapted for use with piston rings for internal combustion engines. In carrying out the invention the rings are preferably blanked for cutting from a suitable lathe and the disks are clamped between irregular heads and the stack of spring blanks thus clamped or distorted is subjected to a suitable temperature for a sufficient length of time to permit a setting of the ring.

(Continued on page 114)

ANY MODERN PICKLING ROOM IS A USER OF PICTROL + + +

Pictrol is a chemical which is added to the pickling solution. It "inhibits" the action of the acid on steel and iron without retarding its action in removing the scale.

When Pictrol is used, the following improvements in the pickling operation are observed.

1. A saving in acid is effected since acid is used to remove scale and not to eat away the metal.
2. Less tonnage of metal is wasted in pickling.
3. Over-pickling is prevented.
4. Machines or threaded parts can be safely pickled without danger of marring the surface.
5. Black scum from over-pickling is eliminated.
6. Fumes are eliminated. When acid acts on clean metal violent gassing takes place and large volumes of acid-laden gas are carried out of the tank. In the presence of Pictrol the acid spends its energy chiefly in removing scale and very little gassing takes place.
7. Acid brittleness is prevented.
8. Production can be increased enormously by stepping up the acid content and by increasing the temperature of pickling.

The addition of Pictrol makes it possible to do this without danger of over-pickling, excessive fumes or any of the other difficulties which would arise without Pictrol.

Pictrol is meeting with unqualified success wherever it is being used.

The price is so moderate that its use is a real economy.

THE WEAVER BROTHERS CO. + ADRIAN, MICH.

WRITE US FOR PARTICULARS

The twelve societies co-operating in National Western Metal Congress are:

American Chemical Society

American Institute of Electrical Engineers

American Institute of Mining and Metallurgical Engineers

American Petroleum Institute, Cal. Div.

American Society of Mechanical Engineers

American Society for Steel Treating

American Welding Society

Institute of Metals

National Purchasing Agents Association

Pacific Coast Electrical Association

Pacific Coast Gas Association

Society of Automotive Engineers

The Great Exposition Auditorium at San Francisco where the 1931 National Western Metal Congress and Exposition will be held

Remember your date
At the Golden Gate
In the winter of Thirty One
So make your plans, and don't be late
To arrive in the land of the Sun

A TRIP THROUGH THE WEST—California at its Height—a trip to Hawaii, if you wish—a weeks' sojourn in San Francisco attending . . .

NATIONAL WESTERN METAL CONGRESS

Where many subjects of vital interest to the metal world will be discussed during the sessions of the twelve cooperating societies (see left column) . . . Concurrently, over 100 manufacturers will exhibit the latest machinery, processes and production methods at

NATIONAL WESTERN METAL AND MACHINERY EXPOSITION

More than 70,000 square feet of exhibit space—at Los Angeles in 1929, over 50,000 visited the exhibits and sessions—a counterpart of the annual National Metal Congress and Exposition . . .

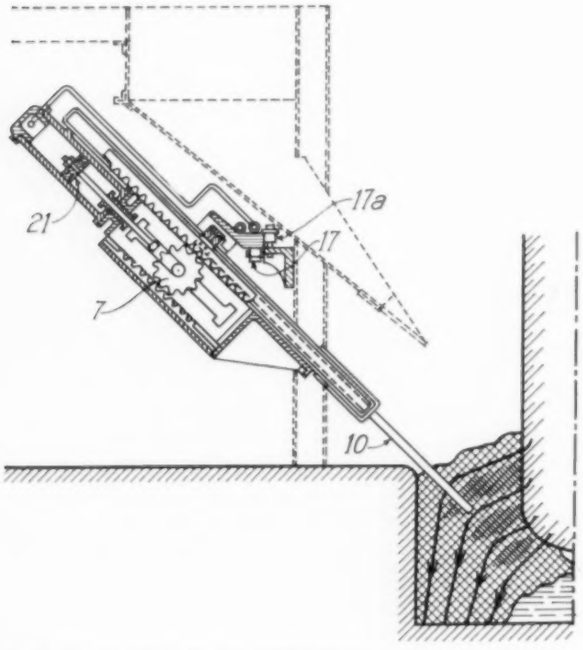
Over 200 Eastern people visited Los Angeles in '29—we expect 500 at San Francisco in '30

CIVIC AUDITORIUM
SAN FRANCISCO, CALIFORNIA
FEBRUARY 16—20, 1931

Alloy Steel, *by John A. Nelson, of Rockford, Ill., assignor to Barber-Colman Co. of Rockford. 1,778,226; Oct. 14.*

This invention is concerned with alloy steels particularly suitable for cutting tools having fine teeth such as thread mills, taps and the like. Such tools are first cut or formed before the hardening or heat treating process. Heat treatment in the usual alloys has often so warped and twisted the tool that it would require a truing process to make it accurate for machine work. The present alloy is an improvement over the prior art and includes carbon varying from 1% to 1.75%, chromium, 4% to 10%; tungsten, 6% to 10%; vanadium, 0.5% to 2%; cobalt, 7% to 8%; and the principal part of the remainder iron. Said tool will be formed accurately prior to hardening and will be substantially undistorted after heat treatment.

Electric Furnace Stirring Apparatus, *by Paul Louis Joseph Miguet, of Montricher, near St. Julien De Maurienne, France, assignor to Societe Electrometallurgique De Montricher, of Saint - Julien - de - Maurienne, Savoie, France. 1,778,809; Oct. 21.*



A stirring or poking apparatus for electric furnaces is disclosed by this patent. As the figure illustrates it includes a plurality of air cylinders at about 45° angle to the vertical, and a rod *10* is adapted to be reciprocated by the piston *21* through operation of the gear *7*. A suitable valve is provided to control the movement of the piston and the cylinder is movable with respect to the furnace due to the rollers *17* and *17a*.

Electric Flash Welding, *by Warren F. Heineman, of Shorewood, Wis., assignor to A. O. Smith Corp. of Milwaukee. 1,780,297; Nov. 4.*

A process of electric flash welding is described in this patent, which comprises first flashing uneven edge portions away to obtain an accurate parallelism of the edges to be welded, then abutting the edges under light pressure while maintaining the application of welding current across them to obtain a distribution of heat in the metal adjacent the edges. A flashing arc is then established between the edges to heat the metal thereof to welding temperature, and finally the edges are abutted under heavy pressure and the welding current discontinued to obtain a fusing and welding of the metal of the edges and to give the required upset to the weld. Such a process has many advantages, among them being that a more uniform heating and more perfect weld is obtained. The resistance heating of the edges also provides a deeper penetration of heat and serves to prevent too rapid cooling.

Zinc Die-Casting Alloy, *by Edmund A. Anderson, of Palmerton, Pa., assignor to the New Jersey Zinc Co. of New York. 1,779,525; Oct. 28.*

A zinc base die-casting alloy which does not effect the melting pot which must be of iron and steel is covered in this patent. It has been found that a certain amount of aluminum is necessary to minimize this attack and certain other percentages are necessary to insure fluidity. In the present invention the alloy preferably contains from 2% to 15% aluminum, from 0.01% to 0.3% magnesium in which the zinc base is zinc metal of high purity containing not more than 0.003% lead, not more than 0.003% cadmium, and not more than 0.001% tin. The improved alloy exhibits remarkable retention of its physical properties after accelerated aging, permitting the use of die-castings made at elevated temperatures and in the presence of moisture without impairment of physical properties. Many other advantages are also found in this new alloy for die casting.

(Continued on page 118)

$1.00 WORTH OF NICKEL MAKES THIS $10,000 DIESEL PERFORM BETTER LONGER

JUST the price of a few quarts of oil... that's the cost of the small amount of Nickel needed to give a set of Diesel engine piston rings increased wear-resistance and smoother performance.

Cast iron alloys containing Nickel are also used for cylinders and other engine parts to prevent vital parts from grinding themselves into obsolescence.

When added to cast iron, steel, stainless steel, brass, bronze or aluminum, Nickel imparts one or more of these desirable properties: (1) grain refinement; (2) increased hardness; (3) improved wear-resistance; (4) strength and toughness at elevated temperatures.

Nickel alloys "perform better longer." Why not let our engineers suggest how and where they will fit into your plans for product improvement?

Send for Bulletin 206—"Data on Wear-Resistance and Machinability of Cast Iron."

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ALLOYS
PERFORM BETTER LONGER

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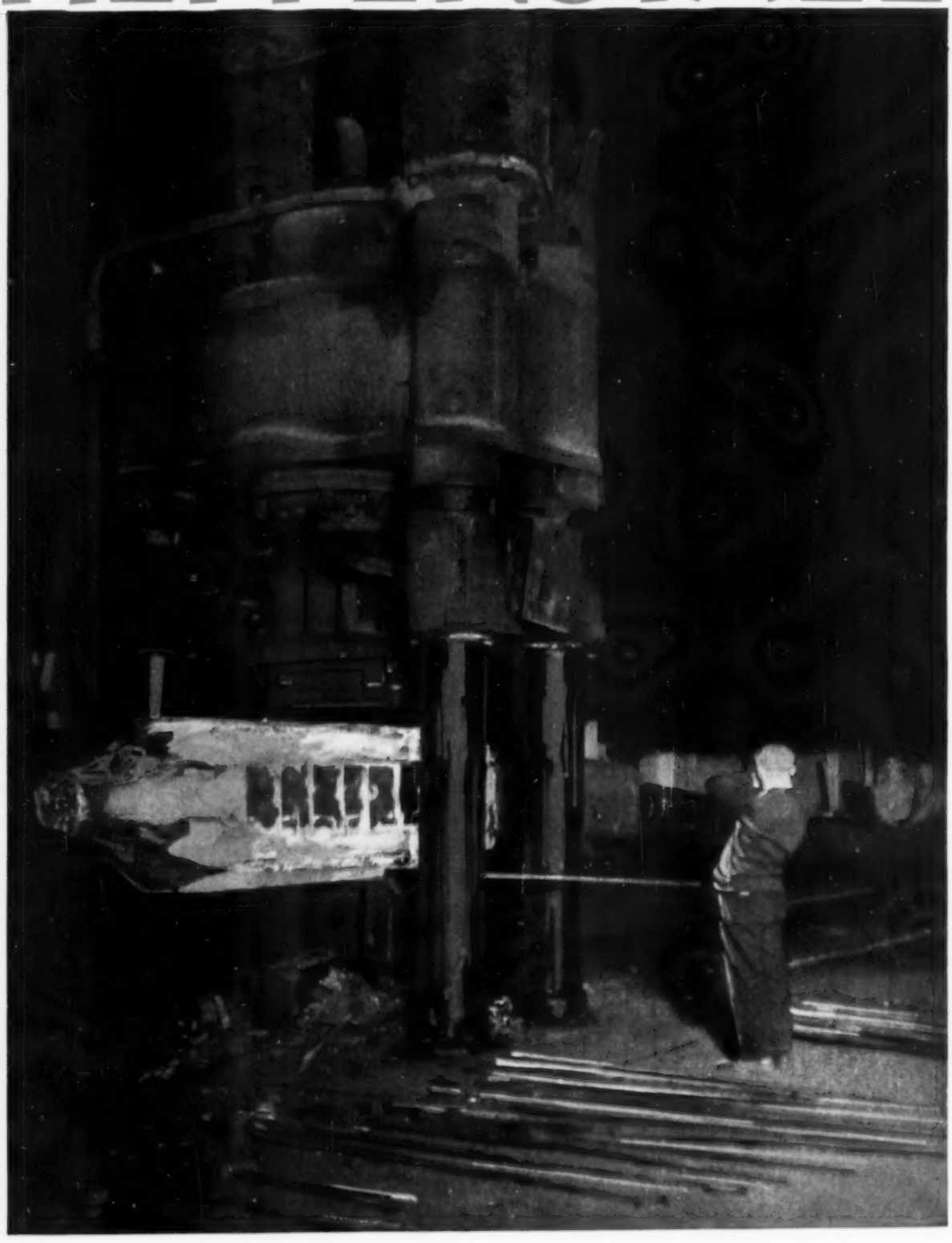


FOR 42 YEARS

. . . A NAME THAT HAS STOOD FOR QUALITY SERVICE & SATISFAC-TION IN DIE BLOCKS SHEAR KNIVES E. I. S. (ELECTRIC INDUCTION STEEL) & FORGINGS

HEPPENSTALL

COMPANY

BRIDGEPORT . . . . PITTSBURGH . . . . DETROIT

Hardenable Lead Alloy, *by Michael G. Corson, of Jackson Heights, New York. 1,780,261, Nov. 4.*

This patent relates to a lead alloy which may be hardened by heat treatment. The theory of this process is based upon the assumption that antimony up to 2½% stays in solid solution in lead at the temperature of heat treatment, remains so initially after quenching is completed and is precipitated in an ultra-microscopic form during aging. Generally, however, such alloys have certain drawbacks and one of the metallic compounds of antimony is substituted for the elementary antimony, this second metal compound being soluble to a substantial degree in solid lead. The alloy described in this patent contains as its major element lead but also contains from 0.5% to 15% each of antimony and cadmium. Such an alloy may be heated to a temperature of 200° C., which is lower than the melting point, for a sufficient period of time to bring the antimony and cadmium into solid solution in the lead matrix. The alloy may then be cooled to produce supersaturation which is followed by aging.

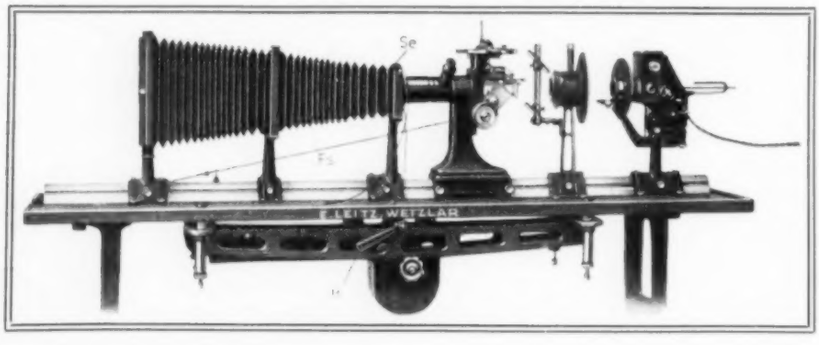
Electrode, *by Truman S. Fuller, of Schenectady, N. Y., assignor to General Electric Co. 1,778,668, Oct. 14.*

Electrodes particularly for butt welding machines are covered. It is pointed out that in the common forms of welding such as spot welding, line welding, and butt welding it is desirable that the electrodes have a relatively low resistance and good heat conductivity. In the present construction electrodes are made of an alloy of copper, silicon and elements such as nickel, cobalt or chromium, but preferably nickel. Such electrodes have a hard, wear-resisting contact surface and preferably contain about 96% copper, 0.8% silicon, and about 3.2% nickel. This alloy has a Brinell hardness ranging between 125 and 175 and its electrical resistance is approximately three or four microhms per centimeter cube.

LEITZ MICRO - METALLOGRAPH "MM"

INVERTED MICROSCOPE with Camera

for: *Micro Analysis and Photo-Micrography of Metal Specimens.*



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through Precision mechanical workmanship and alignment » Perfection of optical equipment » Greatest assortment of objectives and eyepieces to meet any and all requirements » Flatness of field over entire plate (including size 8″x10″) » Immunity against external vibrations in the laboratory » Quickness and ease of operation.

WRITE FOR CATALOG NO. 1057

and learn of the many additional features to know that the Leitz "MM" is the Equipment built to satisfy and to render the greatest range of application.

Inform us of your requirements; our technical bureau is at your service, to make recommendations and to offer assistance in solving your problem.

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TECHNICAL NEWS REEL

(1) Engineers and physicists of the U.S.S.R. are setting an example by collaborating in making a thorough investigation of the possibilities opening up to the X-Ray method of examining materials. At the Second All-Union Conference on Metal Research, which was held in Moscow in May 1930, twenty-seven papers were read on the subject "The Plastic Deformation of Metals". Of these, fourteen were reports of investigations based on X-ray study. Many Soviet schools are providing courses on radiology. It's going to be too bad when they put the X-ray on some of those German alloy castings.

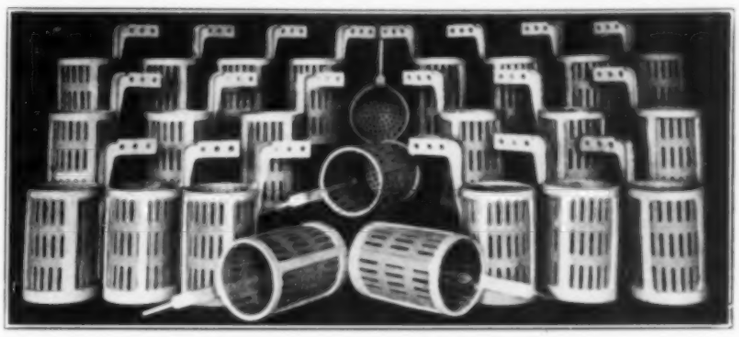
(2) Of the three types of corrosion mentioned by E. H. Dix in a recent paper, particular stress is placed upon the type known as "intergranular" corrosion, which may occur in certain of the heat treatable aluminum alloys. This kind of corrosion proceeds along the grain boundaries, and considerable deterioration may occur before visual inspection is permitted to discover the defect. A decrease in tensile strength and marked reduction in elongation are the results of such corrosion.

(3) And now, of especial interest to electroplaters, comes the statement that heat treated chromium deposits are much more resistant to calcium chloride corrosion (test spray) than the regular plate. Treating at 450° F. for one half hour drives off the undesirable occluded hydrogen, which, in the case of chromium direct on copper, results in an increase of seven times the normal corrosion life.

(4) The color characteristics of manufactured articles can be determined quickly by a comparative study after suitable exposure to the old type carbon-arc electric light—nearest approach to artificial sunlight, says W. J. Miskella in "Industrial Finishing".

(5) Proper grinding of the cutting tool is the best remedy for eliminating the chip bug-bear again brought before the shop by the advent of tungsten-carbide tools; this seemes to be the consensus of opinion of the group of engineers expressing themselves upon the subject.
A suitable top rake (15-20°) will produce a small curl which will break up itself without imparting too much heat.

(6) Aha! Two German professors have established the fact that either of two types of small beetles may be held strictly accountable for the destruction of lead water pipes, gaskets, telephone cables—in fact anything lead to which they may have access. During the course of their experiments, the two professors found that two such insects required only four hours time to eat through a lead plate 0.008" thick. Tin foil is attacked to a lesser degree, and other metals such as aluminum, zinc or brass, not at all.



SHEET DIPPING BASKETS . .

THE General Alloys Co. originated sheet alloy dipping baskets for cyanide and salt solutions . . . These may look simple at first glance, but when you consider the stress of rapid heating and cooling in dipping in and out of hot solutions, sometimes even the basket is quenched, you realize the design problem in tying the thin sheet in with the stronger framework.

Many of these baskets have been in service for years. They are rapidly replacing the thoroughly antiquated base metal baskets and the more modern but inefficient alloy wire basket which carried out large quantities of salts in its interstices.

These baskets have been widely imitated in the last two years, which is merely another testimonial to their merit.

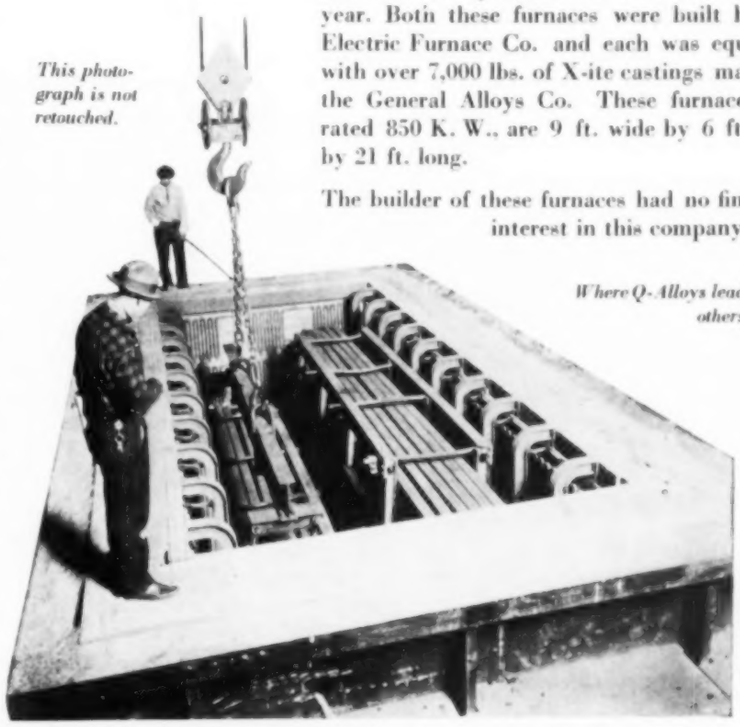
SPEAKING OF PIT FURNACES?

WHILE NEW electric pit furnaces of other types are being tried, while alloys unproven in such service are being tested, two of these electric annealing furnaces, the first large electric pit furnaces ever installed in an alloy steel mill, are delivering dependable service. One has run over three years, the other is in its second year. Both these furnaces were built by the Electric Furnace Co. and each was equipped with over 7,000 lbs. of X-ite castings made by the General Alloys Co. These furnaces are rated 850 K. W., are 9 ft. wide by 6 ft. deep by 21 ft. long.

The builder of these furnaces had no financial interest in this company.

Where Q-Alloys lead, others follow.

This photograph is not retouched.



FROM MAINE

...*with* CHESTER

Ed. Note: After two months of not reporting to his Boss, "Gawge" Koldshot, V. P. of the Porous Castings Corporation, Freddy Shrinks, Star Salesman, got the pink slip. Chester Field Day, Freddy's "Ape of an Asst.," got orders to cover Shrink's territory. Here's Chester's report:

West Overshoe, Me.

Dear Mr. Koldshott:

Here pepperin' papermills. One third is shut down count of Missoury competition. One third snowbound. Other half is busy convertin late summer flypaper into early spring sandpaper. Helped uncover fundimental cause business depreshion, viz: lots of potentail buyers aint bought nuthin. Principal exports is early american antiques, imports Cuban mapel suggar. Gennywine antique manufacturers has got to wear badges like Chicago Booticians to keep from silicitin competitors. That pulp likker in them regesters is wikked, Mister Koldshott, it's lappin the smoothon right outer our castings, you could play 'em on a Aeolian. The head paper maker at the Non-Skid Coupon Works is liberal. When he was reeling he says "take a sheet for yourself," (I took two—one for you Mister Koldshott).

CHESTER.

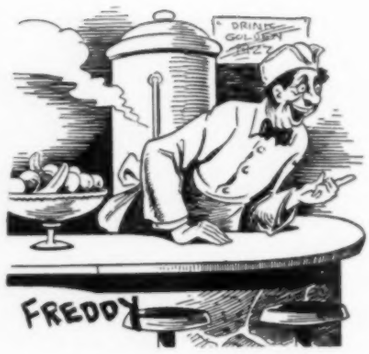
P. S. Submit enclosed sheet as sample, all out of credit memos.

Boston.

Dear Mr. Koldshott:

Have your wire that you got a Nixrusto license and want me to push 7 & 11 in place of 5 & 10 alloy and to go for the resterants. I've been goin fer the resterants and honest Mister Koldshott who should I meet but Freddy.

Freddy's presidin at the Hurricane



Beannery in South Boston. This spot is so tough that the flies kick hell out of the sparrows. Freddy has a new patent, a "Pittsburgh washcloth" viz.:—One cup wheatcake batter, one tablespoon thumb tacks, brown on griddle and sew back to back into mitten. (Note: Buckwheat stands up better). Freddy says Genl. Alloys is hard hit, there molders is bein hired off them by Jewelers. This Sump-Pump Company is gone hay-wire and bot a mikrowscope. There Metalografist sez he found a oat in our alloy, and I instruks him we use Ferrobolonium as a oxydyzer. This is a Sportin town. Me and Freddy an a sister act seen Freddys Cockroach "Hurricane" place secund in A&P Derby. One is called Big-Hearted-Hannah, (two of 'em couldn't sit on the Hippodrome stage). They named cannons after her sister Bertha. This team of teasers learned wig-wag signals and had half the atlantic fleet on the rocks all summer. Two Bos'ns is still in drydock. Bertha thot they was Men-O'-War and cristened 'em with quarts. *P. S.* Please send more samples of them Pickels and Passivaters we use on our Norusto and Korrodo NG3. "Pop" Titas, Janitor at the "Hurricane" drank 'em both, celebratin' his 93rd Birthday.

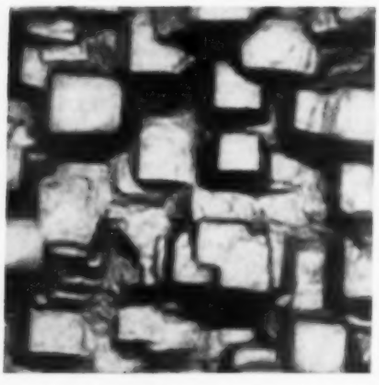
CHESTER.

New Yawk—Friday

Dear Mr. Koldshott:—I'm fagged to a frazzle makin' Freddys prospects. All of them prospects is up three or four flights. Callin' on the Half-Moon Tool Hardening Works I climb three flights and pass four exit lights—only they was no exits. You could smell fun and trouble a block away. "Where's your card" says a stenog peekin through the letter slit in the door. Well Mister Koldshott i ain't carried no card since gettin excummunicated outta the Springfield Plummers Local for sweatin joints. "I'm lookin for heat, corrosion and abrasion," sez I marchin' in. You shud have seen that tub, Mister Koldshott, it had a hole runnin thru to the cellar. It couldent a bin austinitic, or maybe pickled but unpassified. But,—everythings Jake,—got a nice order for still parts, baffles and detonator clubs by givin' 'em scrap credit and talkin' reciprosity. Hired a aerplane to inspect them competative alloy tests on top of the latest aviation hazards. Like you sed they is sure subjected to atmospheric exposure. The latest bull-etin is that maybe it won't take. Went to Coney Island with a couple broilermakers. That place is the cats! Who shud we meet but our old frend "Bud" Hain, you know him Mister Koldshott, he came from Boonville Missoury as skinner to a car of siteless razorback hawgs which was misplaced around South Union Ave. and Fortieth out in Chi. Bud has been sellin' lictric Furnaces while drownin' his grief, but he just kain't keep his mind offen them hawgs,—starts lookin' for blind pigs when the whistle blows. Bud was detourin' from Pittsburgh to Chi and had along a sheet and pair prospect, a Finnish puddler who'd dive fer a fin. (see encl. photo).

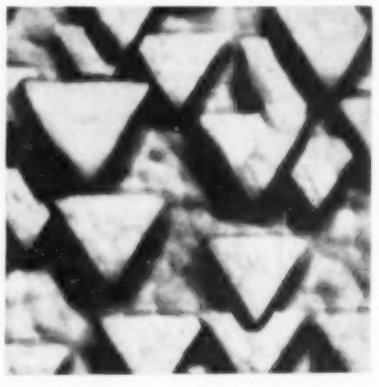
CHESTER.

P. S. "Pop" Titas from the "Hurricane" Beannery just wired "Send me another bottle, my wife dont mind my cold feet now."



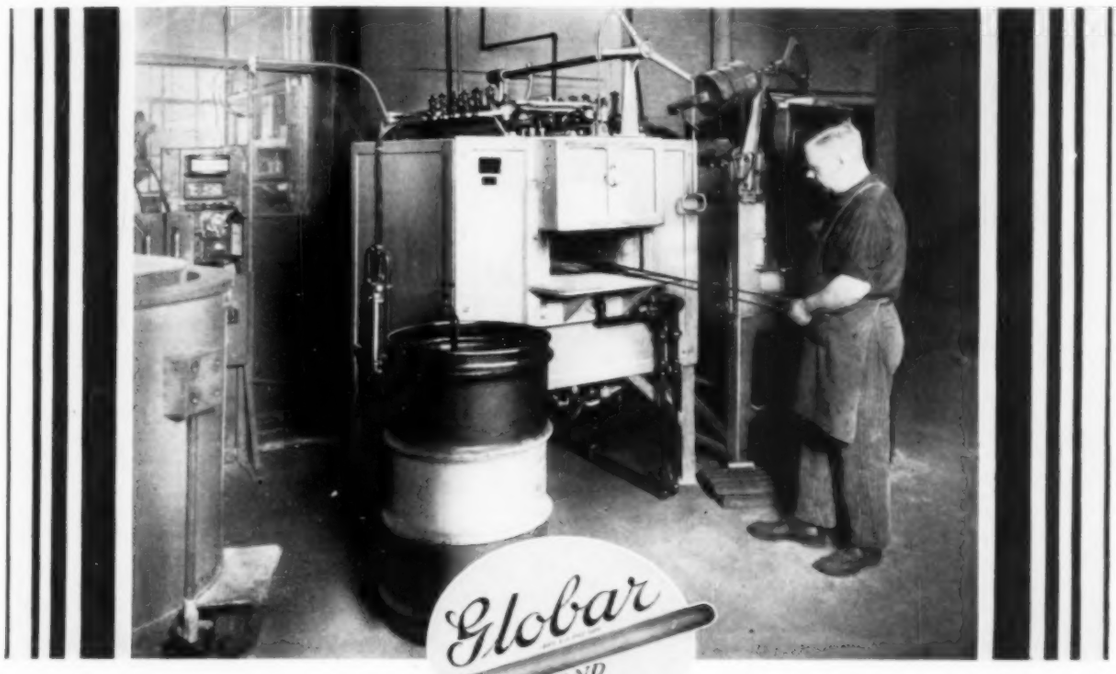
Q-ALLOY... This specimen was prepared by a special method to reveal structural characteristics peculiar to the Q-Alloy composition of the nickel-chromium series. Conically oblique, magnetic arc illumination, Wratten B filter, Wratten plate, 1.32 N. A. objective, one-minute exposure comprise the photomicrographic conditions.

The metallurgy and metallography of alloys of the nickel-chromium system is a field distinct and apart from that of either the ferrous or non-ferrous systems. So foreign is this field that even special methods of sample preparation and etching were necessary to develop the microstructures shown here. Metallographists will not recognize these structures as typical of either of these alloys and they do not correspond to photomicrographs common to the literature as these constitute basic structures revealed only for the manufacturing control of the products. These photomicrographs reveal a difference comparable to the physical characteristics of these two alloys, whereas the average photomicrograph does not positively differentiate.



X-ITE... This specimen was prepared by a special method to reveal structural characteristics pecular to the X-ITE composition of the nickel-chromium series. Conically oblique, magnetic arc illumination, Wratten B filter, Wratten plate, 1.32 N.A. objective, one-minute exposure comprise the photomicrographic conditions.

Satisfied— THOROUGHLY SO



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¶ This installation is used in treating high speed steel. There is no guess work. Temperatures are accurately controlled, making it possible to produce day after day a given quality of product.

¶ The result is the production of better treated steel with scaling and burning eliminated.

¶ Such Globar equipped furnaces insure continuity of perfectly heated material—greater production per furnace—practically eliminating rejections—lowering operating costs.

It is possible that Globar Engineers can help solve your heating problems.

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FOR THE ASKING

. . . HELPFUL LITERATURE . . .

Furnaces—Ryan, Scully & Co. 32-page booklet describing and illustrating various furnace installations in many leading plants. Full-page photos of these furnaces are included. Ask for bulletin No. E-1.

Automatic Furnaces—Hyro Mfg. Co., Inc. Booklet fully describing the new Hyro Automatic Furnace for case hardening and tempering. Turns out better work, faster and at less cost, in absolute safety. Adaptable to all types of work. Bulletin No. E-2.

X-Rays—General Electric X-Ray Corp. "Industrial Application of the X-Ray", a forty-page brochure explaining the value of X-rays in various industrial processes and describes the apparatus required for this work. Fifty selected radiographs are illustrated. Ask for bulletin No. E-3.

Induction Steel—Heppenstall Co. 12-page booklet describing the production of electric induction steel, illustrated. Bulletin No. E-4.

Brinell Machines—Tinius Olsen Testing Machine Co., a new edition of their bulletin describing production Brinell Machines, and complete equipment for testing hardness of all materials, including very large parts, thin sheets, small objects, case hardened and nitrided surfaces, etc. Ask for bulletin No. E-5.

Car-Bottom Furnace—Surface Combustion Co. Leaflet describing a recent installation of this type of furnace. Ask for bulletin No. E-6.

Heat Resisting Alloy—Ohio Steel Foundry Co. 20-page bulletin on Fahrite Heat Resisting Alloy, showing photographs of typical installations of this material. Bulletin No. E-7.

Buyers Guide—International Nickel Co. Buyers Guide to Nickel Alloy Steel Products. A tabulation of sources of supply for the more commonly used forged, rolled, cast or drawn products made from nickel steels and alloys. Ask for bulletin No. E-8.

Car-Type Furnaces—George J. Hagan Co. Bulletin covering various car-type furnaces built and installed by this company. Bulletin includes photographs of typical installations. Ask for bulletin No. E-9.

Alloy Steel Handbook—Republic Steel Corp., has available a revised edition of the Agathon Alloy Steels Handbook. This contains complete instructions for the heat treatment of the various steels in chart form for easy reading. Ask for bulletin No. E-10.

Heating Machines—American Gas Furnace Co. Bulletin covering the eight different types of heating machines in general use. This bulletin also covers automatic quenching tanks. Ask for bulletin No. E-11.

Alloys—Calorizing Co. Heat Enduring, Corrosion Resisting Alloys. A technical bulletin giving physical properties of nickel-chromium iron alloys at all operating temperatures. Photographs of typical applications are included. Ask for bulletin No. E-12.

Gas Heat—American Gas Association. Send for a copy of the new book Gas Heat. No charge. Gas is now the preferred fuel for all industrial purposes. Ask for bulletin No. E-13.

Refractory Cements—Botfield Refractories Co., have prepared a 12-page booklet describing high temperature fire brick cements, including chrome cements and mixtures for surfacing and bonding fire brick in all types of furnaces. Bulletin No. E-14.

High Temperature Alloy—Michigan Steel Casting Co. A 16-page bulletin containing illustrated descriptive matter of their alloy castings and fabricated products for use in high temperatures. Ask for bulletin No. E-15.

Metal Progress, 7016 Euclid Ave., Cleveland.

Please have sent to me the following literature as described under "Helpful Literature for the Asking" in January METAL PROGRESS. (Order by number.)

.....

Name .....

Position .....

Firm .....

Address .....

Furnaces—American Electric Furnace Co., has a 4-page bulletin 30-5 describing the intermediate sizes of box-type electric furnaces, all of which are equipped with their patented atmospheric control. Ask for bulletin No. E-16.

Furnaces—W. S. Rockwell Co. Booklet on Rockwell Heat Treating and Carburizing Furnaces, enclosed front type, fuel or electric, for annealing, hardening, etc. Ask for bulletin No. E-17.

Research Equipment—E. Leitz, Inc. Guthrie-Leitz Research Equipment for Grinding and Polishing of Metallographic Specimens with Automatic (Magnetic) Specimen Holder designed to operate in a most efficient manner and permitting the preparation of Metal Specimens at a minimum of expense and time. Bulletin No. E-18.

Heat Treating Equipment—Case Hardening Service Co. 24-page catalog of supplies and accessories for heat treating plants. Contains numerous illustrations and many helpful suggestions for economic heat treating and equipment operation. Bulletin No. E-19.

Heat Treating Wall Chart—Chicago Flexible Shaft Co. Chart covering temperature conversion, heat treatments for S.A.E. steels and other data for handy reference in the heat treating department. Bulletin E-28.

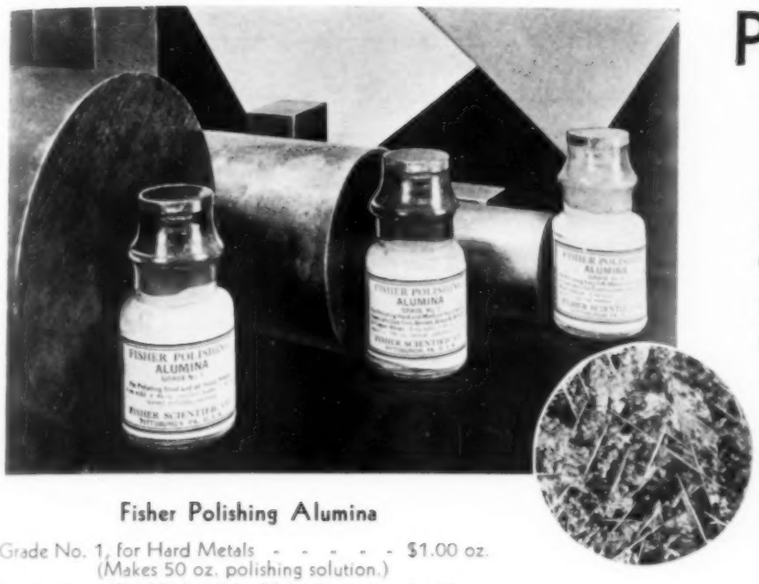
Supertemp—Bethlehem Steel Co. A new folder describes Supertemp, a steel developed for parts that must retain their strength and be free of creep at high temperatures. Ask for bulletin No. E-21.

Ferro Alloys—Electro Metallurgical Sales Corp., has issued the third edition of "Electromet" Ferro Alloys and Metals which describes fully the products furnished by this Corporation to the various metallurgical industries. Ask for bulletin No. E-22.

Alloys—General Alloys Co., has gotten out a new bulletin on chrome nickel and straight chrome heat and corrosion resisting alloys known as bulletin E-23.

Automatic Temperature Cut-out—Hevi Duty Electric Co. A new leaflet has been published describing the new

Continued on page 144



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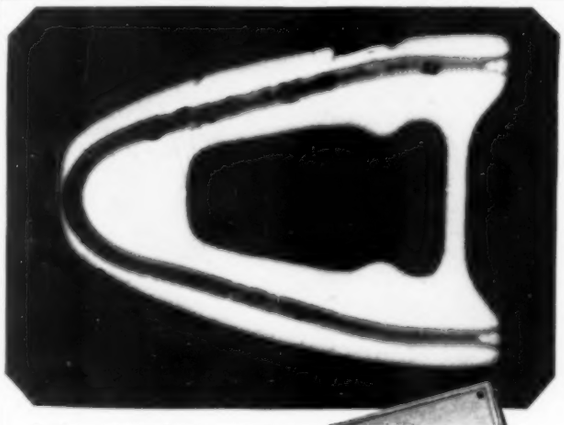

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"Automatic Temperature Cutout," which can be applied to any type of furnace. Ask for bulletin E-24.

Time Cycle Contactors — Automatic Temperature Control Co. Cycle controllers for the regulation of process operation are described in detail in the revised bulletin on timer application. Ask for bulletin No. E-25.

Ludlum Steel Catalog—Newly revised catalog of tool and alloy steels; sectioniter type incorporating three complete sections;—general information regarding Ludlum products, technical data, and a reference book of steel treating tabulations. Bulletin No. E-26.

Alloys, Heat-Resisting — Driver-Harris Co. A brochure illustrating interesting Nichrome installations. Nichrome is the original heat-resisting casting. Ask for bulletin D-1.

Testing Machines—Steel City Testing Laboratory. Bulletin describing Brinell, tensile and sheet metal testing machines. Ask for bulletin D-2.

Ascoloy 55—Allegheny Steel Co. A technical bulletin describing this chromium iron alloy will be sent on request. Ask for bulletin D-5.

Hardness Testers—Wilson-Maeulen Co. Bulletin H-9 describing applications of the Rockwell hardness tester to a variety of types of work in many different industries. Bulletin D-7.

Hy-Ten Steel—Wheelock, Lovejoy and Co. Hy-Ten steels range in carbon from .10 to 1.00 per cent. There is a Hy-Ten grade for every vital machine part. Bulletin D-8.

Fatigue Testing Machine—Thompson Grinder Co. A bulletin describing the rotating beam type fatigue testing machine. Giving interesting data on fatigue testing. Bulletin D-9.

Chromel Resistance Wire—Hoskins Mfg. Co. Catalog and handbook describing Chromel resistance wire and other resistance alloys, also thermocouple alloys, giving technical information and data. Bulletin D-10.

Globar Heating Elements—Globar Corporation. Bulletin "Globar Non-Metallic Electric Heating Elements" which gives the physical characteristics and applications of Globar elements. Bulletin D-12.

Steel Treating—Park Chemical Co. Booklet covering various heat treating processes and chemicals used to properly produce the results desired in the finished product. Bulletin D-13.

Ingot Molds — Gathmann Engineering Co. A new book covering the subject of ingot molding. It contains numerous illustrations of the effects of various methods of finishing and casting on the reliability of steel products. Booklet C-1.

Tool Steels—Carpenter Steel Co. Bulletin "Timbre and How It Affects the Properties of Carbon Tool Steel." Defines Timbre and illustrates and describes Timbre testing. Published by the research department. Bulletin C-6.

Deoxidizers—Vanadium Corp. of America. Leaflet describing Alsifer, a material used for the deoxidation of steel during manufacture. Ask for bulletin No. B-6.

Corrosion and Heat Resisting Steels—Colonial Steel Co., Vanadium Alloys Steel Co., and Anchor Drawn Steel Co. Booklet gives complete data regarding stainless A, stainless B, stainless I, stainless FMS, stainless N, stainless U and stainless CNC. It is intended for shop men to whom it gives valuable technical information. Ask for bulletin No. B-4.

Heat Treating Chemicals—Roessler and Hasslacher Chemical Co. Booklet "Case Hardening and Heat Treatment of Steel." Comprehensive data on cyanides for surface hardening, physical properties and methods of use of salt baths for drawing, annealing and general hardening. Ask for bulletin No. B-13.

Fuel Fired Furnaces — Electric Furnace Co. Eight-page bulletin illustrating oil and gas fired continuous and batch type billet heating, forging and car type furnaces for heating, normalizing and heat treating, also labor saving material handling equipment. Ask for bulletin No. B-18.

Nirosta Buyers Guide — Krupp Nirosta Co., Inc. A concise listing of Companies, producing Nirosta metal, their addresses and the forms of material they are prepared to furnish. Ask for bulletin No. B-19.

Furnaces—Strong, Carlisle and Hammond Co. invites your requests for their bulletins and reprints of recent furnace installations. Your inquiries are solicited. Ask for bulletin No. B-20.

Potentiometers—Thwing Instrument Co. "The Treasure Chest" is a highly accurate portable potentiometer, a laboratory in itself, completely self contained with standard cell, batteries, resistance coils, self checking feature, stations for checking thermocouples and for reading temperatures from thermocouples. Ask for bulletin No. B-23.

Slushing Compound — The Skybryte Co. Steelbrite is an entirely different rust preventing compound from ordinary oils and greases. It has none of their objectionable features and gives greater protection to sheet and strip steel and fabricated parts. Ask for bulletin No. B-24.

Industrial Regulators—Minneapolis-Honeywell Regulator Co. Booklet describing their motorized valves used in furnace temperature regulation. These valves operate with their regulators or with any pyrometric controller to regulate flow of gas, oil and air. Ask for bulletin No. A-2.

Resistance Thermometers—Leeds and Northrup Co. Revised catalog treating in detail resistance thermometers for recording, controlling and indicating temperatures, covering heating and ventilating, applications in refrigeration and chemical plants, gas-making and other low temperature applications. Ask for bulletin No. A-3.

Steel Handbook—Jos. T. Ryerson & Sons, Inc. Handbook on Tool and Alloy Steels. Description, technical data and general information on tool and alloy steels. Also nontechnical description of heat treating methods and shop practice applying to various steels. Ask for bulletin No. A-8.

Induction Furnaces—Ajax Electrothermic Corp. This bulletin gives latest information regarding coreless induction furnaces in capacities up to several tons, and motor-generator equipments for energizing the furnaces. Ask for bulletin No. A-9.

Corrosion Prevention—Dearborn Chemical Co. Booklet describing latest scientific methods of treating water for prevention of scale, corrosion and foaming in steam boilers, dealing with related problems in connection with scale and corrosion in other power plant equipment. Ask for bulletin No. A-10.

Heat Resisting Steels—Midvale Co. Booklet is largely a diagrammatic classification showing the content of the various alloys. It was produced because of a large number of requests for exactly this type of information. Ask for bulletin No. A-11.

Tool Steel Handbook—Columbia Tool Steel Co. Booklet contains valuable information concerning the making of tools, heat treating, application of steels, with tables, etc., gratis. Ask for bulletin No. A-13.

Pickling Equipment — Weaver Bros. Co. Catalog listing equipment and supplies now available. Depicts all necessary equipment and has new "theory and practice of pickling." Ask for bulletin No. A-17.

Pyrometers—Charles Engelhard, Inc. Bulletin describing features of indicating and recording pyrometers. Treats on such subjects as sensitivity, resistance, support and control of moving oil, and temperature coefficient. Bulletin E-29.

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. . . THE ENGINEERING INDEX

In the preparation of the Engineering Index by the staff of the American Society of Mechanical Engineers some 1700 domestic and foreign technical publications are regularly searched. From this material the A.S.S.T. is supplied with this selective index to those articles which deal particularly with steel treating and related subjects. Registered United States, Great Britain and Canada.

BEARING METALS

Predicting the Behavior of a Babbitt, A. H. Levy. *Power*, vol. 72, no. 19, Nov. 4, 1930, pages 720-721.

Discounting great importance usually attached to Brinell hardness tests in determining value of babbitt; discussion of what tests are suitable and what worthless.

Automobile Bearing Metals, C. Upthegrove. *Am. Soc. Testing Matls. (Symposium on Developments in Automotive Materials)* at mtg., Mar. 19, 1930, pages 78-91 and (discussion) 92-102, 9 figs.

Some of more dominant characteristics and factors affecting metals used as bearing metals in automobiles; factors affecting selection of bearing metal; classification; babbit metal; bronzes, light metal-base alloys.

CAST IRON

Gusseisen; Eigenschaften und Pruefverfahren. *Bericht ueber die Tagung des Fachausschusses fuer Werkstoffe in V. D. I., Oct. 28, 1929. Berlin, V. D. I. Verlag, 1930*, 96 pages, illus., tables, 6.-r.m.

Series of addresses delivered at meeting of Materials Division of German Society of Engineers; properties and structure of cast iron, workability of various types, and influence of various methods of cooling on structure and resistance to wear of automobile cylinder castings are presented, together with methods of mechanical testing used by various large firms; experience of users of cast iron. Eng. Soc. Lib., N. Y.

BRAZING. Repair of Cast Iron Machine Parts by Gas Melting Process Making Use of Special Bronze (Reparaturarbeiten an Grauguszmaschinenteilen mit Hilfe des Gasschmelzverfahrens unter Verwendung von Specialbronze), A. Glatzel. *Autogene Metallbearbeitung (Halle)*, vol. 23, no. 20, Oct. 15, 1930, pages 325-328, 6 figs.

CORROSION. Corrosion and Heat Resistant Nickel-Copper-Chromium Cast Iron, J. S. Vanick and P. D. Merica. *Iron and Steel of Canada (Gardenvale)*, vol. 13, no. 11, Nov. 1930, pages 241-242 and 260-261 and 263, 1 fig.

Development of low cost nickel-copper-chromium cast iron; data on composition, physical properties, and principal application.

Surface Quality and Scale Resistance of Cast Iron (Oberflaechenbeschaffenheit und Zunderfestigkeit), R. Mitsche. *Giesserei (Duesseldorf)*, vol. 17, no. 43, Oct. 24, 1930, pages 1047-1048, 3 figs.

Influence of surface properties and structure on resistance to hammer scale formation; experimental study of protective action of surface treatment; for case described, surface treatment does not offer increased protection; on contrary, removal of more resistant skin, tends to decrease resistance to the formation of any further amount of scale.

RESEARCH. Cast Iron Research. *Engineering (Lond.)*, vol. 130, no. 3381, Oct. 31, 1930, page 563.

British Cast Iron Research Assn., founded in 1921 is national body; it has fostered and coordinated research work; ninth annual report of association which covers year ending June 30, 1930, gives indication of extensive activities of organization; experimental work falls into three main sections, namely, researches in connection with cast and malleable iron, investigation of cupola-furnace problems and work on auxiliary materials, molding sands, refractories, dressings and fuel.

British Cast Iron Research Association. *Brit. Cast Iron Research Assn.—Bul.*, no. 30, Oct. 1930, pages 296-325.

Work of council and research Committee, publication and education committee; state and industrial research; recent development in cast iron and foundry practice; bibliography and abstracts from foundry literature; includes report by J. G. Pearce on national scheme of education in foundry matters.

WEAR. Influence of Structure and Composition of Cast Iron on Abrasive Strength, with Special Regard to Phosphorus Content (Einfluss des Gefuegezustandes und der Zusammensetzung von Gusseisen auf die Verschleissfestigkeit, mit besonderer Beruecksichtigung des Phosphorgehaltes), T. Klingenstein. *Mitteilungen aus den Forschungsanstalten (Nuernberg)*, vol. 1, no. 1, Sept. 1930, pages 18-24, 10 figs.

Wear resistance of cast iron is dependent upon different factors, such as basic material, nature of graphite separation, volume of graphite separation, and hardness of basic material; pearlitic structure of great hardness is objective to be sought.

CORROSION PREVENTION

Effect of Drainage and Insulating Joint Methods for Prevention of Electrolytic Corrosion of Underground Metallic Structures, M. Horioka and M. Iwasa. *Electrotech. Laboratory—Researches (Tokyo)*, no. 288, May 1930, 82 pages, numerous figs.

Effect of two methods for prevention of electrolytic corrosion of underground metallic structures, using either drainage connection or insulating joint for power and communication cables, from data obtained by laboratory experiment and field survey.

New Methods in Study of Corrosion and Protection of Metallurgical Products Against Corrosion (Quelques nouveautés d'ordre chimique dans l'étude de la corrosion et dans la protection des produits métallurgiques contre la corrosion), J. Cournot. *Société Chimique de France—Bul. (Paris)*, vol. 47-48, no. 8, Aug. 1930, pages 802-825.

Theories of corrosion and experimental methods of investigation; résumé of methods of protecting metals from corrosion, by coating with other metals or with paints, and by anodic treatment.

ELECTROPLATING. The Resistance of Electro-Deposits to Corrosion with Special Reference to Cadmium and Zinc, W. S. Patterson. *Sheet Metal Industries (Lond.)*, vol. 4, no. 6, Oct. 1930, pages 462-463.

Tests show that destruction of coating is occurring very much more rapidly in case of cadmium than in case of zinc; mechanism of atmospheric corrosion of zinc and cadmium. Paper read before Electroplaters' and Depositors' Tech. Soc.

GALVANIZING. The Influence of Cadmium in a Galvanizing Bath, H. Bablik. *Metal Industry (Lond.)*, vol. 37, no. 18, Oct. 31, 1930, pages 411-413, 6 figs.

(Continued on page 150)

Heat Treating
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BARS of any section from ¼ inch to 8 inches and in any length up to 25 feet can be normalized, quenched, annealed, and tempered in this unique electric heat-treating department of a progressive steel mill.

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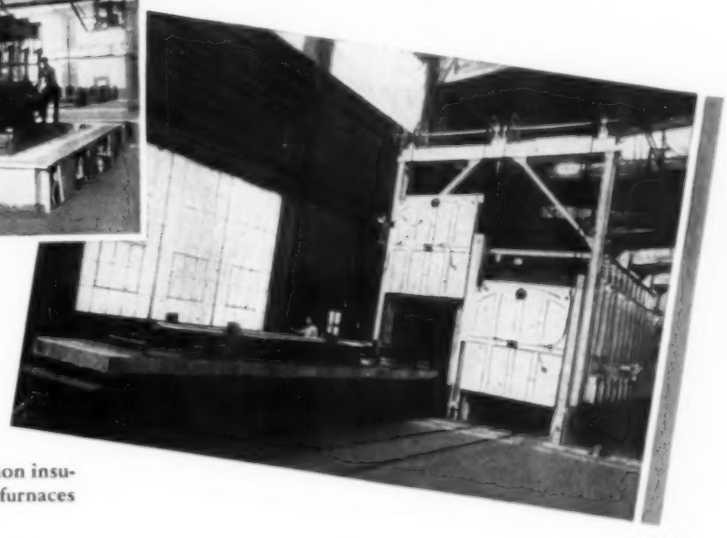

Two car-bottom drawing furnaces with a common insulated center wall. Cars are run in and out of furnaces by motor-driven spur gears

570-150

ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

PARKERIZING. Rust Protection of Machinery by Phosphate-Containing Baths (Der Rostschutz von Maschinen durch phosphathaltige Baeder), H. Kalpers. *Maschinenkonstrukteur (Munich)*, vol. 63, no. 20, Oct. 25, 1930, pages 395-398, 7 figs.

Chemical reactions in parkerizing process and data on concentration of solution; table gives data on parkerized, sherardized, galvanized nickel plated and otherwise protected surfaces regarding air corrosion resistance under different conditions of exposure.

DIES

MANUFACTURE. Die Design and Diemaking Practice, edited by F. D. Jones, N. Y., Industrial Press, 1930, 921 pages, illus., $6.00.

Describes current practice in making dies for blanking, forming and drawing sheet metal, and illustrates principles by many examples of standard and special dies; brings together large amount of experience not to be had readily elsewhere. Eng. Soc. Lib., N. Y.

COLD HEADING. Cold Heading Die Life, A. S. Jameson. *Metal Stampings*, vol. 3, no. 10, Oct. 1930, pages 927-928.

Factors controlling life and production of cold heading dies; steel, design, heat treatment, bolt material, and machine operation; table gives data on chemical composition of cold heading die steels in per cent. Abstract of paper presented before Am. Soc. for Steel Treating.

DIE CASTINGS

Properties of Die Castings Affected by Casting Practice, C. Pack. *Iron Age*, vol. 126, no. 20, Nov. 13, 1930, pages 1386-1388, 2 figs.

Factors influencing physical properties; position of alloy, rate of cooling, casting machine and die; pressure, heating and speed of operation; principles govern gating. Paper read before Am. Inst. Min. and Met. Engrs., previously indexed from Tech. Pub., no. 346, Sept. 1930.

Die Casting in Birmingham. *Metal Industry (Lond.)*, vol. 37, no. 16, Oct. 17, 1930, pages 361-363, 6 figs.

Methods, layout and equipment of works of F. H. Adams (1926), Ltd.; most of dies made at present are gravity castings.

DIE CASTING ALLOYS. Advances In Die-Cast Metals For Automotive Use, C. Pack. *Am. Soc. Testing Matls. (Symposium on Developments in Automotive Materials) at mtg.*, Mar. 19, 1930, pages 54-63, 1 fig.

These die-casting alloys are considered: tin-base, lead-base, zinc-base, aluminum-base, magnesium-base, or those alloys which have a copper base.

ELECTRIC WELDING

Electric Welding, E. W. Lewis. *Elec. Rev. (Lond.)*, vol. 107, no. 2761, Oct. 24, 1930, pages 684-685.

Application of welding in boiler manufacture; atomic-hydrogen welding. (Concluded.)

STRUCTURAL STEEL. Influence of Current in Arc Welding Soft Steel (Einfluss der Schweissstrombedingungen bei der elektrischen Lichtbogenschweissung von weichem Flussstahl), N. Lefring. *Forschungsarbeiten auf dem Gebiete des Ingenieurwesens (Berlin)*, no. 332, 1930, 53 pages, 59 figs. 10.-r.m.

Research directed toward ascertaining relation between current conditions and fusing process in welding steel, and toward establishing influence of current conditions on strength of weld; comparative seam-welding tests carried out with a.c. as well as d. c. with either pole location made with different metal thicknesses and under wide variations of current intensity.

WELDING MACHINES. Developments in Arc-Welding Appliances. *AEG Progress (Berlin)*, vol. 6, no. 11, Nov. 1930, pages 352-354, 8 figs.

Various types of A.E.G. automatic arc-welding equipment; including longitudinal seam-welding automatic plant; welding equipment for longitudinal and circular seams; welding plant for longitudinal seams; automatic welding machine for piping.

Electric Welding Equipment. *Elec. Rev. (Lond.)*, vol. 107, no. 2761, Oct. 24, 1930, pages 707-708, 6 figs.

Various designs of British make are illustrated and described. (Concluded.)

(Continued on page 152)

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"Hansa-Rotrans" Three-Phase Arc Welding Machine (Drehstrom-Lichtbogen-Schweissmaschine "Hansa-Rotrans"). *Zeit. fuer die Gesamte Giessereipraxis (Berlin)*, vol. 51, no. 44, Nov. 2, 1930, pages 387-389, 4 figs.

Machine is single-shaft transformer, that is, motor and generator are on same shaft; equipped with roller bearings for grease lubrication.

FOUNDRY PRACTICE

Some Scientific Principles of Casting Metals, H. C. Dews. *Foun-* 741, Oct. 30, 1930, pages 303-304 and 308.

Scientific considerations which govern production of perfect castings; cause of discontinuities which reduce density of castings; mechanism of solidification, contraction and expansion phenomena; table gives data on volume changes in freezing of non-ferrous metals; effect and origin of gases; crystallization theories. Bibliography. Exchange paper on behalf of Inst. Brit. Foundrymen to French Foundry Tech. Assn., Oct. 24-25, 1930.

Temperature Determinations Without Measuring Instruments in Foundry Melting Practice (Temperaturbestimmungen ohne Messapparate in Schmelzwerken), M. Stromeyer. *Zeit. fuer die Gesamte Giessereipraxis (Berlin)*, vol. 51, no. 42, Oct. 19, 1930, *(Metall)* pages 170-172.

Three different conditions are discussed when use of pyrometry is not required in temperature measurements; typical examples are given to show that use of measuring instruments is not always necessary, and in certain cases, not expedient.

NON-FERROUS. White Metals, Brasses and Bronzes, E. Perry. *Metal Industry (N. Y.)*, vol. 28, no. 11, Nov. 1930, pages 512-513.

Types, constituents, properties and methods of making fusible alloys; solders and brazing compounds; nickel-silver mixtures; fluxes for soldering and brazing. (Concluded.)

Preventing Unsoundness in Bronzes and Red Brass. *Foundry*, vol. 58, no. 22, Nov. 15, 1930, pages 47-50 and 54, 1 fig.

Effect of furnace atmosphere, effects of oxidation, and laboratory researches on composition of gases contained in bronze and red brass. (Concluded.)

FOUNDRY PRACTICE. The Founding of Bronze Gear Blanks, F. W. Rowe. *Foundry Trade Jl. (Lond.)*, vol. 42, nos. 722 and 723, June 19, 1930, pp. 449-450 and 464 and June 26, pp. 569-570, 9 figs.

June 19: Problems involved; methods of raw material control; melting, molding and casting practice; requirement of gear blanks. June 26: Methods of centrifugal casting; other types of casting.

Modern Practice in Non-Ferrous Foundries (Neuzeitliche Arbeitsweisen in der Metallgiesserei), E. Becker. *Zeit. fuer die Gesamte Giessereipraxis (Berlin)*, vol. 51, nos. 43 and 44, Oct. 26, 1930, (supp.) pages 173-174, and Nov. 2, pages 177-178, 3 figs.

Treatment of scrap and secondary metal is discussed; foundry cleaning methods.

HEAT TREATMENT

CASE HARDENING. The Structure of the Case in Cyanide-Hardened Steel, W. Henninger and H. Jurich. *Eng. Progress (Berlin)*, vol. 11, no. 11, Nov. 1930, pages 297-298, 4 figs.

It is possible by etching with hot concentrated sodium-picrate solution to render presence of eutectoid and needles visible in straight low-carbon steel treated in cyanide bath for five hours with following slow cooling; carburization taking place in cyanide bath is remarkable in that in marginal structure well-developed cementite veins and laminal pearlite are visible.

CHAINS. Promal Chains. *Mech. Handling (Lond.)*, vol. 17, no. 11, Nov. 1930, pages 365-366.

Chain manufactured by Link-Belt Co. embodies new method of processing malleable iron which gives metal greater strength and wearing quality than old method.

CRACKS. Stresses and Cracks in Hardened and Ground Steel, G. R. Brophy. *Metal Stampings*, vol. 3, no. 10, Oct. 1930, pages 933-934.

Stresses introduced by grinding are considerably reduced by tempering; stresses and cracks which occur in hardened steel surfaces due to grinding, and principles to be employed for their reduction. Abstract of paper presented before Am. Soc. Steel Treating, Sept. 22-26, 1930.

SHEET-STEEL. Normalized Sheets and Tinplates, E. E. Griffiths. *Sheet Metal Industries (Lond.)*, vol. 4, no. 6, Oct. 1930, pages 427-429, 4 figs.

Methods of box annealing and single-sheet annealing are discussed; microphotographs illustrate effect on crystal structure. (To be continued.)

SPRINGS. Heat Treating Spiral Springs with Natural Gas, D. W. Frye. *Natural Gas*, vol. 11, no. 10, Oct. 1930, pages 32 and 34, 1 fig.

Furnace installation at Pittsburgh is illustrated; data on production, total and unit gas consumption during three months operation of furnace for heat treatment of spiral springs made from bar steel.

IRON AND STEEL

METALLURGY. Metallurgists and Chemists Handbook. Compiled by D. M. Liddell. 3rd edition. N. Y., McGraw-Hill Book Co., 1930. 847 pages, tables, $5.00.

Collection of physical, economic, chemical and mechanical data in pocket size book; new edition has been carefully revised and contains much added material. Eng. Soc. Lib., N. Y.

Solubility of Oxygen in Solid Iron (Ueber die Loeslichkeit des Sauerstoffs im festen Eisen), E. Scheil. *Stahl und Eisen (Duesseldorf)*, vol. 50, no. 44, Oct. 30, 1930, pages 1530-1531, 2 figs.

Review of research work, with special reference to work of J. Kempkens; (see Engineering Index 1929, p. 1014) low values obtained by him for oxygen solubility are considered by present writer to be nearest approach to accuracy.

METALLOGRAPHY. Studies of Ternary System Iron-Carbon-Oxygen Based on Measurements made by R. Schenck (Betrachtungen ueber das Dreistoffsystem Eisen-Kohlenstoff-Sauerstoff auf Grund der Messungen von R. Schenck), E. Scheil and E. H. Schulz. *Stahl und Eisen (Duesseldorf)*, vol. 50, no. 42, Oct. 18, 1930, pages 1469-1471, 4 figs.

Report on phase-rule study of gas equilibria of iron with its oxides and carbides; results and conclusions.

NON-FERROUS ALLOYS

Hardness of Metal Alloys at Various Temperatures (Die Haerte der Metallegierungen bei verschiedenen Temperaturen), W. Schischokin and W. Agejewa. *Zeit. fuer anorganische und allgemeine Chemie (Leipzig)*, vol. 193, no. 3, Oct. 21, 1930, pages 237-244, 10 figs.

Report from Leningrad Polytechnic Institute on experimental study of hardness of alloys: bismuth-tin, bismuth-cadmium, lead-cadmium, tin-cadmium, lead-tin, tin-zinc, and zinc-cadmium for temperatures up to 200 deg. cent.

The Occlusion of Lead and Copper in Nonferrous Alloys by Metastannic and Metantimonic Acids, S. del Mundo. *Philippine Jl. of Science (Manila)*, vol. 43, no. 3, Nov. 1930, pages 403-407.

Study on adsorption and occlusion of lead by metastannic and metantimonic acids, formed by nitric-acid attack on non-ferrous alloys; in white metals containing tin and antimony in lead base, quantity of lead occluded varies from 1 to 3 per cent; in alloys high in tin, however, quantity of lead and copper that may be occluded varies from 0.1 to 0.5 per cent; satisfactory method has been worked out for direct determination of lead in white metals containing tin and antimony in lead base.

P.M.G. Metal Hardener. *Machy. (Lond.)*, vol. 3, no. 942, Oct. 30, 1930, pages 143-145, 4 figs.

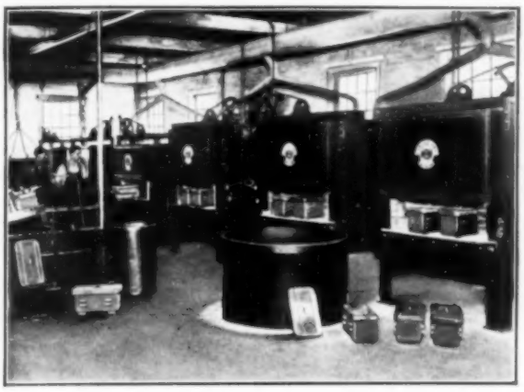
Results of tests on casting and forging with P.M.G. hardener, developed by Vickers-Armstrong; composed of copper, iron and silicon, and employed to replace tin in all copper alloys; tables give data on physical property and comparison of properties of cast P.M.G. metal and admiralty gunmetal; comparison of properties of forged P.M.G. metal with worked 70/30 brass and 9 per cent aluminum bronze.

Nickel Alloys; Some Personal Experiences, W. R. Barclay. *Metal Industry (Lond.)*, vol. 37, no. 18, Oct. 31, 1930, pages 414-416.

Metallurgy of nickel alloy with particular regard to German silver; use of electrolytic zinc; effect of zinc on color; deoxidizing agents; pouring temperatures; influence of carbon. (To be concluded.)

(Continued on page 154)

BETTER HEATING



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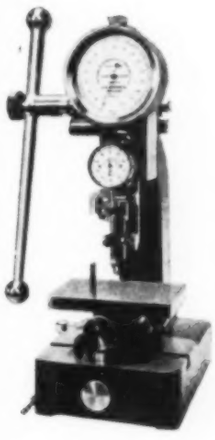

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OXYACETYLENE WELDING

Tenth International Congress of Acetylene, Autogenous Welding and Allied Industries, At Zurich, July 9-12, *Welding Jl. (Lond.)*, vol. 27, no. 325, Oct. 1930, pages 303-307.

Abstracts of papers by J. Baillaud, D. Seferian, H. Melhardt, C. F. Keel, M. Ros, M. A. Desgrandes, C. Bottini, A. Fraenkel, R. Sarazin, C. Simon, H. Gerbeaur.

Welding instead of Casting (Schweissen an Stelle von Giessen), H. Holler. *Autogene Metallbearbeitung (Halle)*, vol. 23, no. 19, Oct. 1, 1930, pages 299-302, 10 figs.

General advantages of welding are illustrated by design of charging funnel for gas producer.

COST CONTROL. Welding and Cutting Costs. *Acetylene Jl.*, vol. 32, no. 5, Nov. 1930, pages 169-170.

Table developed by Office Central de l'Acetylene, Paris, gives data on relation between thickness of steel plate, diameter of welding rod, speed of welding, gas consumption in cu. ft. per ft. of weld; cutting and welding.

FLAME TEMPERATURE. Welding Facts and Figures, D. Richardson. *Welding Jl. (Lond.)*, vol. 27, no. 325, Oct. 1930, pages 294-296, 1 fig.

Review of principal literature with particular regard to work on oxyacetylene flame and blowpipe efficiency by A. Stephenson; graph illustrates temperature at various distances from tip of white cone; requirement of blow-pipe design especially of low-pressure type.

PIPE. Welding of Pipe Lines in Domestic Installations (Schweissverbindungen von Rohrleitungen bei Hausinstallationen), C. F. Keel. *Zeit. fuer Schweisstechnik (Journal de la Soudure) (Zurich)*, vol. 20, no. 9, Sept. 1930, pages 294-299, 5 figs.

Advantages of welding with regard to strength and leakage; resistance of welded joints to flow; experiences regarding economy and human factors; practical suggestions for welding procedure.

STRUCTURAL STEEL. Oxyacetylene Welding of Structural Steel (Die autogene Schweissung im Stahlbau), C. F. Keel. *Zeit. fuer Schweisstechnik (Journal de la Soudure) (Zurich)*, vol. 20, no. 9, Sept. 1930, pages 286-294, 19 figs.

Methods of calculating strength of various types of joints; data on permissible stresses; welding and reinforcing of channels and other profiles. (To be continued.) (In German and French.)

PICKLING

The Pickling and Cleaning of Metals, D. Brownlie. *Sheet Metal Industries (Lond.)*, vol. 4, no. 6, Oct. 1930, pages 425-427.

Electrolytic theory of corrosion; phenomenon of catalysis; connection between electric potential of metal and action of acids. (Continuation of serial.)

SHOVELS

HEAT TREATMENT. Gas for Lead Hardening of Shovels, C. G. Segeler. *Iron Age*, vol. 125, no. 26, June 1930, pp. 1880-1882, 2 figs.

Advantages of lead hardening for heat treatment of shovels; practice of Baldwin Tool Works, Parkersburg, W. Va., using lead pot fired with gas, with electrically heated pot to take peak loads.

SHEET MILL PRACTICE

Driving Sheet and Tinplate Mills, J. S. Caswell. *Blast Furnace and Steel Plant*, vol. 18, nos. 10 and 11, Oct. 1930, pages 1630-1631, and Nov., pages 1712-1715, 4 figs. are included.

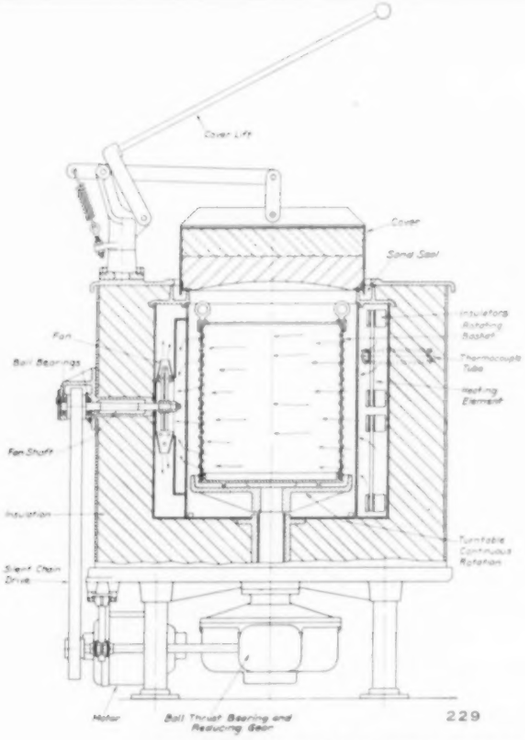
Paper presented before Swansea Tech. College Met. Soc., previously indexed from Foundry Trade Jl., Aug. 28, 1930. (Continuation of serial.)

STEELS

HIGH-SPEED. High-speed Steel Tipped Cutting Tools. *Machy. (Lond.)*, vol. 37, no. 942, Oct. 30, 1930, pages 137-140, 6 figs.

Design and performance of J. B. R. tools made by Rennie Tool Co., East Manchester; effect of plan and cutting angles on cutting speed; cause of chattering; diamond-nosed tool; effect of back slope or front top rake on side slope or side top rake; regrinding of stag major tipped tools; heat-treating methods.

(Continued on page 159)



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HIGH TEMPERATURE. Materials for High-Pressure Installations. *Engineering (Lond.)*, vol. 130, no. 3381, Oct. 31, 1930, pages 544-545.

Review of research and recent papers dealing with strength of steel at high temperatures; investigation of materials which will give greater strength at high temperatures, with less liability to corrosion; recent developments in use of steels containing molybdenum appear to indicate considerable possibilities, creep stress tests showing about double value at 500 deg. cent. that is obtained with nickel steels, and also much lower rate of decrease.

HIGH TESTS. Experiences with Alloyed and Higher-Carbon Boiler Steels (Erfahrungen mit legierten und hoeher gekohlten Kesselbaustoffen), N. Christmann. *Archiv fuer Waermewirtschaft (Berlin)*, vol. 11, no. 11, Nov. 1930, pages 353-358, 12 figs.

Increasing pressures of modern boilers make increased demands on boiler materials; steels for this purpose are now alloyed mainly with copper, nickel, molybdenum, chromium and vanadium, and show marked improvements over older boiler materials; properties of some special steels; aim is manufacture steel of best quality which is not adversely affected by subsequent heat treatment.

Materials for Boiler Construction (Werkstoffe fuer den Dampfkesselbau), H. Jungbluth. *Kruppsche Monatshefte (Essen)*, vol. 11, July 1930, pp. 177-184, 11 figs.

Steam pressures for boilers from 1922 to 1928; strength of ingot steel, and nickel steels; notch values in relation to age and temperature of various types of steel used in boiler construction; materials testing.

STAINLESS STEEL. Stainless Steel, Its Manufacture and Properties (Die rostfreien Staehle, ihre Erzeugung und ihre Eigenschaften), E. Houdremont. *Stahl und Eisen (Duesseldorf)*, vol. 50, no. 44, Oct. 30, 1930, pages 1517-1528, 41 figs.

Classification of stainless steels in ferritic, semi-ferritic and martensitic steels; melting processes; behavior with casting; hot rolling and forging; recrystallization and strain hardening; cold rolling, hammering, drawing and deep drawing; strain-hardening capacity of different stainless steels; recrystallization diagrams; heat treatment; welding; intercrystalline corrosion.

POLISHING. Finishing Stainless Steel, J. Pearsall. *Machy. (N. Y.)*, vol. 36, no. 11, July 1930, pp. 870-872, 4 figs.

Methods used for obtaining mirror finish by applying polishing and buffing operations in correct sequence.

STEEL ANALYSIS

CARBON CONTENT. Magnetic Method for Determination of Carbon in Steel and Its Application in Refining Processes (En magnetisk metod foer kolhaltsbestaemning hos staal och dess anvaendning vid faerskningsprocesserna), C. J. G. Malmberg. *Jernkontorets Annaler (Stockholm)*, vol. 114, no. 10, pages 508-545, 52 figs.

Principles of method of determining carbon content, and design of instrument; possibility of following progress of charge graphically by means of carbo-meter and qualitative and quantitative advantage; diagrams show influence of most common alloy material on carbo-meter readings.

X-RAY. The Quantitative Analysis of Steels by Spectrum Analysis, F. Twyman and A. A. Fitch. *Iron and Steel Industry (Lond.)*, vol. 4, no. 2, Nov. 1930, pages 55-56, 6 figs.

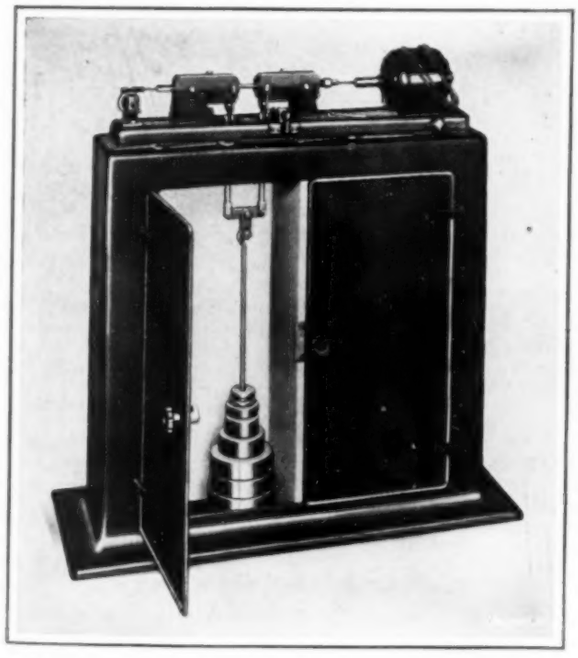
Quantitative analysis of steels by taking spark spectra, using logarithmic wedge sector; data on accuracy of methods in determining content of silicon, chromium, nickel and copper.

STEEL FOUNDRIES

COMPRESSED AIR. The Economic Utilization of Compressed Air in Steel Foundry Practice, T. W. Barley. *Mech. World (Lond.)*, vol. 83, no. 2270, July 4, 1930, pp. 5-7, 1 fig.

Precautions for successful operation of compressor system with details of compressed-air service at works of Edgar Allen and Co., Sheffield, England. Abstract of paper presented before Inst. Brit. Foundrymen.

(Continued on page 160)



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ALLOY. Alloyed Cast Iron and Steel (Legierter Guss), E. Kothny. *Giesserei Zeit. (Berlin)*, vol. 27, no. 12, June 15, 1930, pp. 323-327.

Cast iron alloyed with aluminum and with special alloys; alloyed chill castings. Bibliography. (Concluded.)

Steel Foundry Specializes in Railroad Castings, N. F. Hindle. *Foundry*, vol. 58, no. 12, June 15, 1930, pp. 42-47, 12 figs.

Description of layout, equipment and operations at plant of Scullin Steel Co., in St. Louis; data on output, handling of materials, and composition of steel; sketches show layout of side frame flasks used in shop and location of buildings in foundry department.

Steel Foundry Specializes in Railroad Castings, N. F. Hindle. *Foundry*, vol. 58, no. 13, July 1, 1930, pp. 113-116, 6 figs.

Notes on cleaning and pattern-shop; sketch shows mechanism of straight edge used in pattern shop for layout work. (Concluded.)

Research and Promotion Will Aid Castings Industry, R. L. Wensley. *Steel (formerly Iron Trade Rev.)*, vol. 87, no. 2, July 10, 1930, pp. 50-51 and 60.

Conditions in industry; need for co-operative effort and correction of internal malpractices; advertising for wider markets; advantage of made mark.

STEEL INGOTS

CASTING. Modern Steel Pouring Plant, K. R. Binks. *Metallurgia (Lond.)*, vol. 1, no. 6, and vol. 2, no. 2, Apr. 1930, pp. 249-250 and June, pp. 45-66.

Apr.: Some technical points associated with production of sound steel ingots for rolling mills; various methods employed; influence of nozzle design; ladle linings. June: Relation of length to cross-section; production per mold varies; tun-dish casting.

Heterogeneity of an Ingot Made by the Harmet Process, A. Kriz. *Engineering (Lond.)*, vol. 130, no. 3381, Oct. 31, 1930, pages 565-567, 8 figs.

Abstract of paper read before Iron and Steel Inst. at Prague, Sept. 13, 1930, previously indexed from Foundry Trade Jl., Sept. 25, 1930, and Iron and Coal Trades Rev., Sept. 19, 1930.

Corner Ghost in Steel Ingots, S. Maita. *Blast Furnace and Steel Plant*, vol. 18, no. 11, Nov. 1930, pages 1701-1705, 16 figs.

Causes and remedies for corner segregation; relation between corner ghosts and internal cracks; cooking conditions and solidification mechanics; chromium has tendency to assist in formation of corner ghosts, while molybdenum tends to prevent it. Abstract of paper delivered before (Brit.) Iron and Steel Inst., previously indexed from advance paper.

STEEL MANUFACTURE

Common Errors in Steel Making, W. Lister. *Metallurgia (Lond.)*, vol. 1, nos. 5 and 6, Mar. 1930, pp. 200-202 and 214, Apr., pp. 247-249, 5 figs.

Mar.: Ingot casting; casting car wheel centers; casting ladle; nozzle brick; ladle stopper. Apr.: Careful supervision of ingot stock and manner in which it is arranged and protected on stocking ground is emphasized. (Continuation of serial.)

BESSEMER PROCESS. The Preparation of the Metal for Steel Castings in the Converter, J. Leonard. *Foundry Trade Jl. (Lond.)*, vol. 42, no. 722, June 19, 1930, pp. 458-459, 2 figs.

Principle of operation of converter; chemical reactions in converter; methods to use for successful operation.

BESSEMER PROCESS. The Future of the Side-Blown Converter in the Steel Foundry, J. Deschamps. *Foundry Trade Jl. (Lond.)*, vol. 43, no. 724, July 3, 1930, p. 14.

Factors upon which advisability of installing converter plant depends; comparison of process with open-hearth and electric furnace.

CHEMISTRY. Estimation of Reaction Possibilities in Manufacture of Steel with Aid of Physico-Chemical Data (Die Beurteilung der Reaktionsmoeglichkeiten bei der Stahlerzeugung, etc.), H. Schenck. *Stahl und Eisen (Duesseldorf)*, vol. 27, no. 3, July 3, 1930, pp. 953-965 and (discussion) 966, 20 figs.

Notes on "actual" and "best" utilization values of reactions and their relations to extent and trend of chemical conversion; total concentration and concentration of free slag constituents; bearing of best utilization values of manganese, phosphorus and sulphur reactions on slag composition and temperature; conclusions with regard to oxygen absorption of metals.

DENSITE ADDITION. Cleaner Steel of Better Quality Claimed for Special Process. *Iron Age*, vol. 125, no. 26, June 26, 1930, pp. 1894-1896, 10 figs.

Effect of addition of densite which consists of intimate, finely divided mixture of carbon and other chemicals to molten steel; it is said to reduce, eliminate or control solid-non-metallic inclusions and other deleterious constituents so as to change or modify structural characteristics, thereby giving to carbon steel values comparable with those of some of alloy steels and further augmenting present alloy-steel values.

ELECTRIC PROCESS. Electrolytic Steel (Ilferro elettrolittico), R. B. Dupuis. *Metallurgia Italiana (Milan)*, vol. 22, no. 11-12, Sept.-Oct. 1930, pages 855-869, 10 figs.

Summary descriptions of various methods developed in Europe and United States with special reference to method of Societa Italiana Metallurgia Elettrolitica; author sees no future for electric steel industry in peace time.

OPEN HEARTH. Acid Open Hearth or Basic, K. R. Binks. *Iron and Steel Industry, (Lond.)*, vol. 4, no. 2, Nov. 1930, pages 53-54.

Relative merits of acid and basic open-hearth steels with regard to specification requirements for exacting structural purposes; American practice; outside elimination.

Soaking Pits Without Checkers, J. B. Nealey. *Blast Furnace and Steel Plant*, vol. 18, no. 11, Nov. 1930, pages 1707-1708, 3 figs.

Design and performance data of soaking pits in Upson Works of Bourne-Fuller Co., Cleveland, Ohio; checkers have been discarded for refractory tile recuperators or metallic air preheaters, and intermittent reversal of firing and draft has been supplanted by one-way system; sketches give longitudinal section of five-hole soaking pit; plan view of soaking pits showing location of gas burners.

REFINING AGENTS. Develops Mixture for Purifying Carbon and Alloy Steels. *Iron Trade Review*, vol. 86, no. 26, June 26, 1930, pp. 49 and 50, 4 figs.

Value of alloy additions to steel; use of Densite as refining material, which consists essentially of intimate finely divided mixture of carbon and other chemicals, produced by Refined Steel Products Co., Pittsburgh.

TEEMING PHASE. The Ingot Phase in the Manufacture of Rolled Steel Products, J. H. Hruska. *Rolling Mill Jl.*, vol. 4, no. 6, June 1930, pp. 309-312 and 318, 5 figs.

Discussion of steps in solidification of steel ingots, and influence of mold design on soundness of their structure.

STEEL PROPERTIES

Some Good Inexpensive Steels, R. N. Richardson. *Mech. World (Manchester)*, vol. 87, no. 2269, June 27, 1930, pp. 601-603.

It is, perhaps, not so well known that there are a number of steels which are cheap and are capable of giving remarkably good mechanical properties; list of various steels of different compositions with their mechanical properties is given.

STEEL TESTING

MACHINABILITY. Machining Properties of Some Cold-Drawn Steels, O. W. Boston. *Am. Soc. Mech. Engrs.—Advance Paper*, no. 9, for mtg., Dec. 1-5, 1930, 12 pages, 22 figs.

Results of machining tests on 13 cold-drawn screw-stock steels and 2 cold-drawn stainless steels; force required to remove chip by planer tool; energy required to remove chip by single-tooth milling cutter; torque and thrust developed by ¾ in. diam. drill; penetration of ¼ in. diam. drill under constant feeding load; correlation of tests with Brinell, Rockwell, and scleroscope hardness and structure of each bar.

STIFFNESS. Precision Stiffness Meter, D. A. Oliver. *Jl. Sci. Instruments (Lond.)*, vol. 7, no. 10, Oct. 1930, pages 318-322, 1 fig.

Meter suitable for measuring large variety of stiffness is described; deadweight loading is employed and deflections are measured by screw-gage, contact being indicated electrically; its application to number of problems is pointed out and some typical stiffness measurements are given.

(Continued on page 164)

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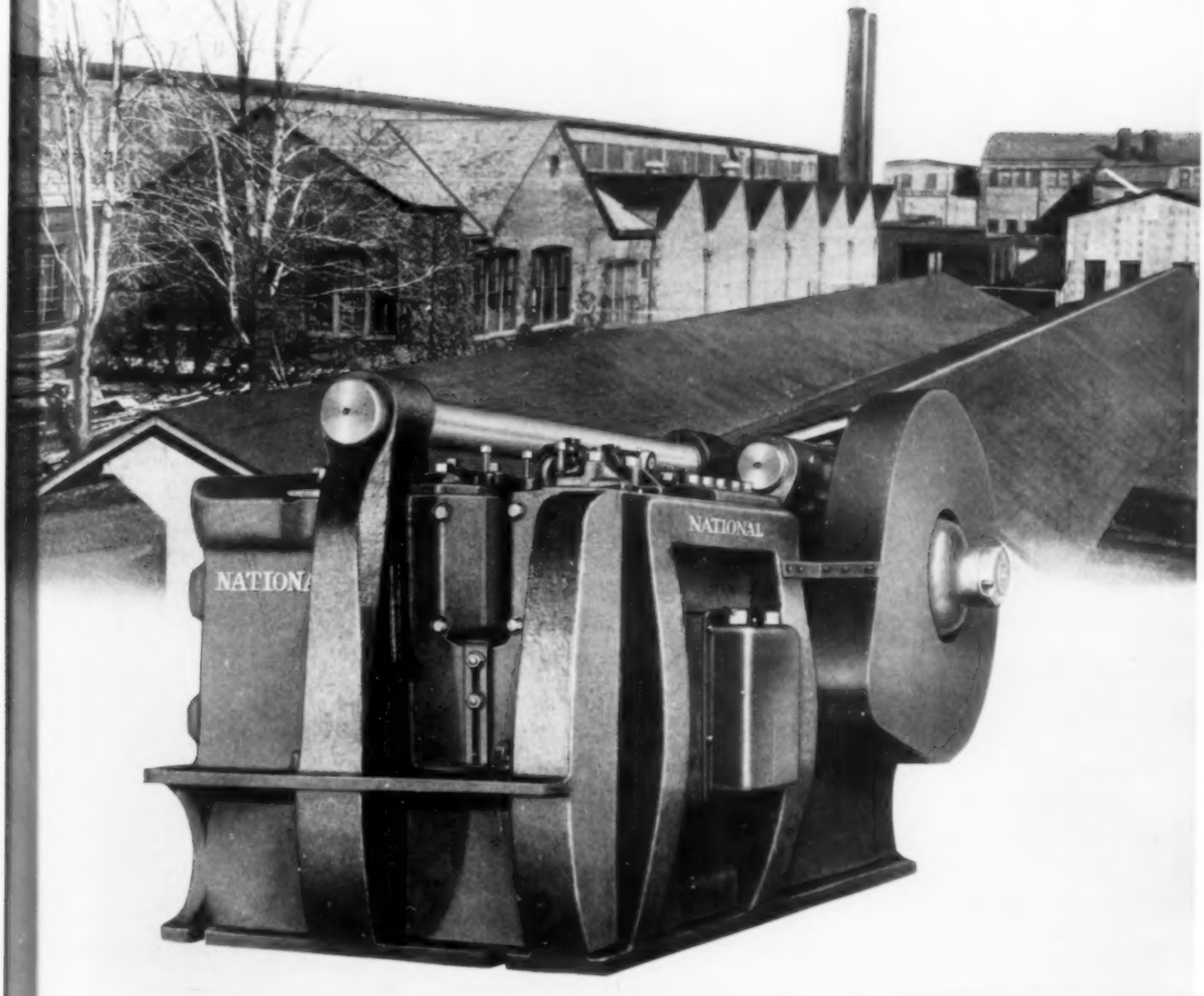

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STRESSES. Use of Telemeters for Measurement of Stresses in Structures (Die Verwendung von Telemetern zu Spannungsmessungen an Bauwerken), F. Treiber. *Bauingenieur (Berlin)*, vol. 11, no. 37, Sept. 12, 1930, pages 633-636, 14 figs.

Description of instrument developed by U. S. Bureau of Standards and report on German tests of this instrument by Probst, at Karlsruhe Institute of Technology.

Internal Stresses in Hollow Cylinders of Tool Steel Estimated, O. V. Green. *Iron Age*, vol. 126, no. 20, Nov. 13, 1930, pages 1378-1380, 3 figs.

Estimation of internal stress on quenched hollow cylinders of carbon tool steel; two methods are submerged flushing and flushing at holes, when quenching; in first case, stresses at holes of such cylinders are either tangential tension or tangential tension and compression combined; in other case, stresses are uniformly tangential compression; "super-tools" result from quenching at hole. Abstract of paper presented before the American Society for Steel Treating.

Fatigue Tests of Large Specimens, R. E. Peterson. *Am. Soc. for Testing Matls.—Proc.*, part 2, vol. 29, 1929, pp. 371-379, 12 figs.

Article indexed in Engineering Index, 1929, p. 1160, from Advance Paper for mtg., June 24-28, 1929.

Nose Formed by Tool in Cutting Metal is Built Up at Any Speed. *Automotive Industries*, vol. 62, no. 26, June 28, 1930, p. 981-2.

Review of paper by O. W. Boston, presented at Machine Shop Practice Session of American Society of Mechanical Engineers, Detroit, on tests with different angle tools on different materials.

Flow Characteristics of Special Fe-Ni-Cr Alloys and Some Steels at Elevated Temperatures, H. J. French, W. Kahlbaum, and A. A. Peterson. *U. S. Bur. of Standards—Jl. of Research*, vol. 5, no. 1, July, 1930, pp. 125-183, 52 figs.

Results of "creep" tests at different temperatures are given for commercial alloys of nickel, chromium, and iron, both with and without tungsten, and low chromium steels containing also tungsten, vanadium, or molybdenum, carbon steel, 3½ per cent nickel steel and low nickel chromium steels.

MACHINABILITY. Machinability and Strength Properties of Steel and Cast Steel (Die Zerspanbarkeit und die Festigkeitseigenschaften bei Stahl und Stahlguss), A. Wallichs and H. Dabringhaus. *Maschinenbau (Berlin)*, vol. 9, no. 8, Apr. 17, 1930, pp. 257-262, 16 figs.

Machinability test data plotted on semi log payer show that doubling of feed reduces permissible cutting speed twice as much as doubling of chip thickness; results of tests give basis of chart for determining cutting speed from Brinell hardness or tensile strength.

Relationships Between Rockwell

(Continued on page 166)

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for strength, toughness and durability

and Brinell Numbers, S. Petrenko. *U. S. Bur. of Standards—Jl. of Research*, vol. 5, no. 1, July, 1930, pp. 19-50, 13 figs.

Comparative Rockwell and Brinell tests were made on great variety of ferrous and nonferrous metals; equations were used as guides in finding empirical formulas which fitted most closely values determined experimentally; of all experimental values obtained in this investigation very few differed by more than 10 per cent from values obtained from these empirical equations.

STEEL TREATING

HEAT TREATING. Heat-treating Furnaces Distributed in Line of Machine Shop Production, H. E. Scarbrough. *Iron Age*, vol. 126, no. 6, Aug. 7, 1930, pp. 357-359, 2 figs.

Description of operation and layout of heat treating facilities at plant of Caterpillar Tractor Co., at Peoria, Ill.; 24 General Electric furnaces with total connected load of 2745 kw. are used; plant will average between 8 and 10 lb. of heat treated parts per kilowatt hour.

HEAT TREATING. Methods and Equipment of a Modern Heat Treating Plant, E. Taylor. *West. Machy. World*, vol. 21, no. 8, Aug. 1930, pp. 332-333, 4 figs.

Description of equipment and methods at plant of Cook Heat Treating Co. of Los Angeles.

STELLITE

The Manufacture and Uses of Stellite, C. W. Drury. *Can. Min. and Met. Bul. (Montreal)*, no. 219, July 1930, pp. 930-944 and (discussion) 945-947, 8 figs.

Note on manufacture of stellite, alloy of cobalt, chromium, and tungsten, with about 2.75 per cent carbon; Rockwell hardness, breaks microscopic, and lathe tests, for cutting tools; stellite cast in form of stelliting rod is also subjected to fluidity and abrasion tests; physical and chemical properties; grades and analyses; uses and applications in industry.

STRENGTH OF MATERIALS

Safety and Stresses in Calculation of Machine Parts (Sicherheit und Beanspruchung bei der Berechnung von Maschinenteilen), F. Roetscher. *Maschinenbau (Berlin)*, vol. 9, no. 7, Apr. 3, 1930, pp. 225-229, 12 figs.

Description of method of determining permissible stresses for various loads; yield stresses, fatigue effects, and safety factors.

CABLES. Reliability of Cold-Drawn Bridge Wire Assured by Recent Test, L. S. Moisseiff. *Eng. News Rec.*, vol. 105, no. 3, July 17, 1930, pp. 93-95, 3 figs.

Report on tests carried out at Lehigh University on cold-drawn bridge wire which replaced failed heat-treated wire for Ambassador bridge at Detroit and Mount Hope bridge at Providence, R. I.; new wire subjected to tension, creep tests, rate of creep curves for cold drawn wire; effect of mishandling; low temperature tests.

STRIP MILLS

Strip Steel Mill of the Acme Steel Co., J. B. Nealey. *Blast Furnace and Steel Plant*, vol. 18, no. 8, Aug., 1930, pp. 1277-1279, 3 figs.

Description of equipment and manufacturing process of Acme Steel Co., Chicago, Ill., for making hot and cold rolled strip steel; automatical installation anneals, cools, pickles, washes and galvanizes strip steel continuously.

TEMPERATURE STRESSES

Thick-Walled Tubes and Cylinders Under High Pressure and Temperature, R. W. Bailey. *Engineering (Lond.)*, vol. 129, nos. 3361 and 3362, June 13, 1930, pp. 772-773 and June 20, pp. 785-786, 4 figs.

June 13: Treatment of subject utilizing information now available; behavior of material; behavior of thin cylindrical tubes. June 20: Stress distribution and creep of thick-walled cylinders under internal pressure. (To be continued.)

TEMPERATURE STRESSES. Thick-Walled Tubes and Cylinders Under High Pressure and Temperature, R. W. Bailey. *Engineering (Lond.)*, vol. 129, no. 3363, June 27, 1930, pp. 818-819, 2 figs.

Thick cylinder under internal pressure with heat transmission through wall; author's tests upon tubes indicate that solid cylindrical test piece should behave as if composed of number of elementary concentric tubes undergoing rates of creep in shear proportional to their radii. (Concluded.)

THERMOMETERS

Temperature Measurements with the Platinum Resistance Thermometer up to 1100 Deg. (Ueber die Temperaturmessung mit dem Platinwiderstandsthermometer bis 1100 Deg.), H. Moser. *Annalen der Physik (Berlin)*, vol. 6, no. 7, Oct. 8, 1930, pages 852-874.

Report from Government Institute of Engineering Physics of Germany giving description of thermometer and method of its use; results of tests of thermometer; discussion of changes in physical nature of platinum produced by high temperatures and their effects on measurements; precision of platinum-platinum-rhodium thermocouple at high temperature.

Selection of Portable Pyrometers (Die Wahl tragbarer Pyrometer), Huetter. *Giesserei (Duesseldorf)*, vol. 17, no. 28, July 11, 1930, pp. 673-677, 7 figs.

Hand pyrometers suitable for foundries and metallurgical plants are discussed with reference to scientific principles of design, advantages and disadvantages.

TOOLS

DRAWING AND FORMING. Drawing and Forming Tools, W. Richards. *Mech. World (Manchester)*, vol. 88, no. 2270, July 4, 1930, pp. 8-10, 4 figs.

Details of design of simpler types used in production of cups on shells from flat circular disks. (To be continued.)

TORSION TESTING

New Power Torsionmeter. *Times Trade and Eng. Supp. (Lond.)*, vol. 26, no. 626, July 5, 1930, p. 402.

New apparatus developed for measuring torsion of shafts under load works by means of elongation of steel thread, stretched out along shafting and fixed to it by two brackets which are themselves fixed to two wrought-iron rings on shafting at definite distance from each other; designed by K. Maihak of Hamburg.

TUBES

BENDING. Bending of Curved Tubes, W. Hovgaard. *Nat. Acad. of Sciences—Proc.*, vol. 16, no. 6, June 1930, pp. 444-451, 5 figs.

Brief outline of tests, and principal results, to determine displacement of ends of pipe bend when subject to compressive end forces; new method of determining transverse strains was developed.

STRENGTH. Hydraulic Tests of Thick-Walled Cylinders, H. Klein. *Mech. World (Manchester)*, vol. 87, no. 2267, June 13, 1930, p. 559, 3 figs.

Experiments undertaken to study hardening and strengthening effect produced in tube by subjecting them to preliminary enlargements beyond their elastic limits. Abstract translated from Kaiser-Wilhelm Institut fuer Eisenforschung.

TUNGSTEN CARBIDE

Tungsten Carbide—the First Product of a New Metallurgy, G. J. Comstock. *Iron Age*, vol. 126, no. 20, Nov. 13, 1930, pages 1381-1383.

Manufacturing methods in compacting and heat treating; heat conductivity of cemented tungsten carbide is approximately 0.21 in cm. gm. sec.; electrical conductivity; magnetic permeability; compressive strength more than 500,000 lb. per sq. in. Abstract of paper read before Nat. Metal Congress.

Carboloy Tool Applications at the Haughton Elevator and Machine Co., C. W. Bennett, *Carboloy*, vol. 2, no. 6, Aug., 1930, pp. 2-5, 4 figs.

Notes on application of carboloy tools at plant at Toledo, Ohio, for turning of cast iron and semi-steel; data on drilling slate with carboloy flat drill.

Carboloy Tool Applications at The Studebaker Corp. of America, H. R. Wentzell. *Carboloy*, vol. 2, no. 6, Aug., 1930, pp. 8-15, 14 figs.

Outline of application of some carbide cutting tools for turning camshafts, aluminum pistons, valve guide bushings; sketches illustrate dimensions and shape of tools; data on performance and savings are given.

Widia Tungsten Carbide Tools, R. D. Prosser. *West. Machy. World*, vol. 21, no. 6, June, 1930, pp. 236 and 237, 11 figs.

Strength, speed, chip pressure, clearance angle, cost and other factors are considered; special ap-

(Continued on page 168)

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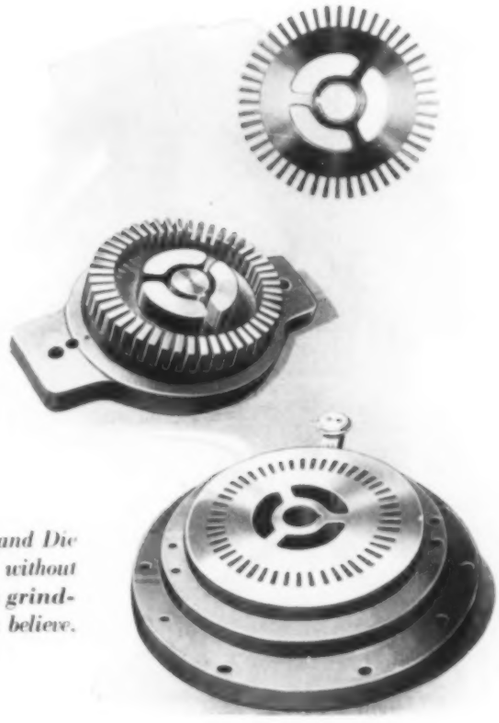

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plicatives are suggested. (Continuation of serial.)

Practical Uses of Widia Tool Metals (Widia-Werkzeugmetall in der Technik), A. Fehse. *Werkstattstechnik (Berlin)*, vol. 24, no. 9, May 1, 1930, pp. 237-244, 40 figs.

Description of experiences made in use of Widia tool metal plates and tips; application to various kinds of tools are illustrated.

Widia Lathe Tools (Widia-Drehmeissel), B. Deja. *Werkstattstechnik (Berlin)*, vol. 24, no. 20, Oct. 15, 1930, pages 559-562, 16 figs.

Important points in preparation and use of tools; table gives data on proper cutting angles for different materials; temperatures in brazing of tips; sketches illustrate testing gages for tools.

WELDING

Tests of Combined Action of Riveted Joints with Welded Seams (Versuche ueber das Zusammenwirken von Nietverbindung und Schweissnaht), H. Kayser. *Stahlbau (Berlin)*, vol. 3, no. 13, June 27, 1930, pages 145-147, 5 figs.

Laboratory tests of riveted joints reinforced with welded seams, in connection with proposed strengthening of existing riveted-steel bridge, have demonstrated advisability of increasing strength of riveted joints with welding around edge of riveted plate.

CORROSION. The Effect of Contamination by Nitrogen on the Structure of Electric Welds, L. W. Schuster. *Engineering (Lond.)*, vol. 130, no. 3380, Oct. 24, 1930, pages 538-540, 4 figs.

Result of those portions of investigation dealing with atmospheric contamination and with structure of welds made in different gases. Paper presented before Iron and Steel Inst., Prague, Sept. 15-16, 1930.

ELECTRIC WELDING. Producing Electric Welded Pipe, A. H. Allen, *Steel*, vol. 87, no. 7, Aug. 14, 1930, pp. 43-46, 9 figs.

Description of manufacturing process and equipment of Republic Steel Corp. for forming and butt welding 8-in. pipe by new process at 40-60 ft. per min.; notes on mechanical tests; microphotographs show structure at various places of pipe.

SHEET IRON. Quality of Welded Seams of Sheet Iron (Die Guete der Schweissnaehte an Eisenblechen), G. Oehler. *Werkstattstechnik (Berlin)*, vol. 24, no. 20, Oct. 15, 1930, pages 549-553, 11 figs.

Comparison of quality of different types of welds by testing for tensile strength; minimum overlap admissible stresses and effect of other dimensions; quality of arc welding and oxyacetylene welding.

STAINLESS STEEL. Welding of Rustless Steels is Making Progress, L. W. Hostettler. *Iron Age*, vol. 126, no. 20, Nov. 13, 1930, pages 1376-1377.

Experiences and method of Allegheny Steel Co.; welding of straight chromium iron; electric arc for welding "18-8" alloy, except on no. 14 and lighter gage sheets, for which gas welding is more practical; need of annealing depends on use of part; practice of Ford Company. Abstract of address before Am. Welding Soc.

TESTING. New Evaluation of Bend Test, W. B. Miller. *Acetylene Jl.*, vol. 32, no. 5, Nov. 1930, pages 159-160, 5 figs.

Proposed method of quantitative bend testing; preparation of specimens; A. S. T. M. specifications for conducting bend tests; data show difference in bend without difference in tensile properties; measured ductility of different welds in tension and bending; elongation in bend test of bars of two steels of various dimensions; effect of speed of closing bend; data warrant that bend test for welds be evaluated by measuring per cent elongation of outside fibers, rather than angle of bend. Paper presented before Am. Welding Soc., Sept. 1930.

Use More Welded Structural Steel in United States, F. P. McKibben. *Steel*, vol. 87, no. 6, Aug. 7, 1930, pp. 48-50.

Typical application of welding in bridges and buildings is discussed; data on stresses and method of calculating and practical application of stress adjustment are given; notes on building code specifications.

Welding Processes. *Times Trade and Eng. Supp. (Lond.)*, vol. 26, no. 627, p. 428.

Several forms of electric and gas welding supply; rapid and economical method of jointing metals; of numerous processes, metallic arc welding has by far widest application; methods of redesigning casting to form of welded structure; table shows some economies actually effected by replacing castings by welded structures of steel.

The International Acetylene Congress, *Engineering (Lond.)*, vol. 130, no. 3366, July 18, 1930, pp. 78-79.

Account of Tenth International Congress of Acetylene and Autogenous Welding, held at Zurich on July 9 to 12; sections dealt with carbide of calcium; acetylene, oxygen and combustible gases; autogenous welding, oxyacetylene, electric and other processes; applications of welding; metal cutting with gases; and regulations to ensure safety in working.

WELDED JOINTS—ENAMELING

Formation of Enamel Blisters on Welded Joints (Die Bildung von Emailblasen auf Schweissnaehten), F. Goldman. *Elektroschweissung (Braunschweig)*, no. 7, July, 1930, pp. 136-139, 7 figs.

Summary of seven causes known so far for formation of blisters on resistance welded seams; formation of carbon on granular limits is eighth cause unknown until now; directions for prevention of blister formation.

WIRE

ANTI-FRICTION BEARINGS. Anti-Friction Bearings in the Equipment for Making Wire, F. Waldorf. *Wire*, vol. 5, no. 7, July, 1930, pp. 270-271 and 291.

Roller bearings on roughing and finishing stands, drawing blocks, stranders and other machines.

Electro-Galvanizing at Oakfield Steel-Wire Works. *Iron and Coal Trades Rev. (Lond.)*, vol. 121, no. 3255, July 18, 1930, pp. 77-79, 8 figs.

Reconstruction of wire drawing department; operation of continuous galvanizing machine designed for wires from 6 to 20 gage; advantages of process; specification for testing of galvanized coatings.

WROUGHT IRON

A. M. Byers Company Plant in Operation, C. Longenecker. *Blast Furnace and Steel Plant*, vol. 18, no. 11, Nov. 1930, pages 87-102, 37 figs.

Layout and manufacturing methods of new $12,000,000 plant located at Economy, Pa.; floor plan of melting department, processing circle, slag furnaces, 800-ton press and 40-in. blooming mill; boiler and gas producer house; layout showing 46-in. universal mill, annealing furnace, transfer tables, hot bed, shear, etc.; list of equipment and contractors.

X-RAYS

METALS ANALYSIS. X-Rays and Metals. *Metallurgist (Supp. to Engineer, (Lond.)*, Aug., 1930, pp. 114-115.

Use of X-ray methods has done much to advance knowledge of metals and alloys; nor can there be any doubt as to prospects of further progress along same road; at same time, this new weapon of research is at present very frequently handled by physicists, who are at times apt to ignore older methods of investigating metals and great mass of data which these have already established.

X-RAY ANALYSIS. X-Ray Examination of Commercial Galvanized Iron by a Modified Reflection Method, C. W. Stillwell and G. L. Clark. *Indus. and Eng. Chem.*, vol. 2, no. 3, July 15, 1930, pp. 266-272, 4 figs.

Modified Technique for obtaining diffraction patterns by reflection has been described, this method being particularly suitable for metals and alloys. Paper read before Am. Chem. Soc., Apr. 7-11, 1930.

X-RAY. Literature on the Use of X-Ray, V. S. Polansky. *Heat Treating and Forging*, vol. 16, no. 7, July, 1930, pp. 876-880.

Bibliography of literature available in Carnegie Library of Pittsburgh up to May, 1930, on x-ray examination of ferrous metals and alloys.

Literature on the Use of the X-Ray, V. S. Polansky. *Heat Treating and Forging*, vol. 16, no. 8, Aug. 1930, pp. 1011-1014.

Bibliography of literature available in Carnegie Library of Pittsburgh up to May 1930 on X-ray examination of ferrous and metal alloys. (Continuation of serial.)